No. 200000065

THE UNITED STATES OF AMERICA

TO ALL TO WHOM THESE PRESENTS SHALL COME:

Johnston Seed Company

Whereas, THERE HAS BEEN PRESENTED TO THE

Secretary of Agriculture

AN APPLICATION REQUESTING A CERTIFICATE OF PROTECTION FOR AN ALLEGED DISTINCT VARIETY OF SEXUALLY REPRODUCED, OR TUBER PROPAGATED PLANT, THE NAME AND DESCRIPTION OF WHICH ARE CONTAINED IN THE APPLICATION AND EXHIBITS, A COPY OF WHICH IS HEREUNTO ANNEXED AND MADE A PART HEREOF, AND THE VARIOUS REQUIREMENTS OF LAW IN SUCH CASES MADE AND PROVIDED HAVE BEEN COMPLIED WITH, AND THE TITLE THERETO IS, FROM THE RECORDS OF THE PLANT VARIETY PROTECTION OFFICE, IN THE APPLICANT(S) INDICATED IN THE SAID COPY, AND WHEREAS, UPON DUE EXAMINATION MADE, THE SAID APPLICANT(S) IS (ARE) ADJUDGED TO BE ENTITLED TO A CERTIFICATE OF PLANT VARIETY PROTECTION UNDER THE LAW.

NOW, THEREFORE, THIS CERTIFICATE OF PLANT VARIETY PROTECTION IS TO GRANT UNTO THE SAID APPLICANT(S) AND THE SUCCESSORS, HEIRS OR ASSIGNS OF THE SAID APPLICANT(S) FOR THE TERM OF TWENTY YEARS FROM THE DATE OF THIS GRANT, SUBJECT TO THE PAYMENT OF THE REQUIRED FEES AND PERIODIC REPLENISHMENT OF VIABLE BASIC SEED OF THE VARIETY IN A PUBLIC REPOSITORY AS PROVIDED BY LAW, THE RIGHT TO EXCLUDE OTHERS FROM SELLING THE VARIETY, OR OFFERING IT FOR SALE, OR REPRODUCING IT, OR PORTING IT, OR EXPORTING IT, OR CONDITIONING IT FOR PROPAGATION, OR STOCKING IT FOR ANY OF THE E PURPOSE , OR CONDITIONING IT FOR PROPAGATION, OR STOCKING IT FOR ANY OF THE ABOVE E, OR USING IT IN PRODUCING A HYBRID OR DIFFERENT VARIETY THEREFROM, TO THE EXTENT PR BY THE PLANT VARIETY PROTECTION ACT. (84 STAT. 1542, AS AMENDED, 7 U.S.C. 2321 ET SEQ.)

BERMUDAGRASS

'Wrangler'

In Testimony Whereof, *I have hereunto set my hand and caused the seal of the* Plant Variety Protection Office *to be affixed at the City of Washington, D.C. this sixteenth day of March, in the year two thousand and five.*

Attest:

Commissioner
Plant Variety Protection Office
Agricultural Marketing Service

Secretary of Agriculture

REPRODUCE LOCALLY. *Include form number and date on all reproductions.* FORM APPROVED - OMB NO. 0581-005

U.S. DEPARTMENT OF AGRICULTURE
AGRICULTURAL MARKETING SERVICE
SCIENCE AND TECHNOLOGY DIVISION - PLANT VARIETY PROTECTION OFFICE

APPLICATION FOR PLANT VARIETY PROTECTION CERTIFICATE

(Instructions and information collection burden statement on reverse)

The following statements are made in accordance with the Privacy Act o 1974 (5 U.S.C. 552a) and the Paperwork Reduction Act (PRA) of 1995.

Application is required in order to determine if a plant variety protectio certificate is to be issued (7 U.S.C. 2421). Information is held confidentia until certificate is issued (7 U.S.C. 2426).

1. NAME OF APPLICANT(S) *(as it is to appear on the Certificate)*
Johnston Seed Company

2. TEMPORARY DESIGNATION OR EXPERIMENTAL NUMBER

3. VARIETY NAME
Wrangler

4. ADDRESS *(Street and No., or R.F.D. No., City, State, and ZIP Code, and Country)*
319 West Chestnut, P.O. Box 1392
Enid, Oklahoma
73701

5. TELEPHONE *(include area code)*
(580)233-5800

6. FAX *(include area code)*
(580)249-5324

FOR OFFICIAL USE ONLY
PVPO NUMBER
20000065

FILING DATE
November 30, 199

7. GENUS AND SPECIES NAME
Cynodon dactylon

8. FAMILY NAME *(Botanical)*
Gramineae

FEES RECEIVED
FILING AND EXAMINATION FEE:
$ 2450.00
DATE
Sept 17, 1999
CERTIFICATION FEE:
$ 432.00
DATE
10/13/04

9. CROP KIND NAME *(Common name)*
Bermudagrass

10. IF THE APPLICANT NAMED IS NOT A "PERSON", GIVE FORM OF ORGANIZATION *(corporation, partnership, association, etc.) (Common name)*
Corporation

11. IF INCORPORATED, GIVE STATE OF INCORPORATION
Oklahoma

12. DATE OF INCORPORATION
4/29/46

13. NAME AND ADDRESS OF APPLICANT REPRESENTATIVE(S), IF ANY, TO SERVE IN THIS APPLICATION AND RECEIVE ALL PAPERS
John Lamle
Johnston Seed Company
P.O. Box 1392
Enid, Oklahoma 73701

14. TELEPHONE *(include area code)*
(580)234-8669
(580)233-5800

15. FAX *(include area code)*
(580)249-5324

16. CHECK APPROPRIATE BOX FOR EACH ATTACHMENT SUBMITTED *(Follow instructions on reverse)*

a. ☒ Exhibit A. Origin and Breeding History of the Variety
b. ☐ Exhibit B. Statement of Distinctness
c. ☐ Exhibit C. Objective Description of the Variety
d. ☒ Exhibit D. Additional Description of the Variety *(Optional)*
e. ☒ Exhibit E. Statement of the Basis of the Applicant's Ownership
f. ☐ Voucher Sample *(2,500 viable untreated seeds or, for tuber propagated varieties verification that tissue culture will be deposited and maintained in an approved public repository)*
g. ☒ Filing and Examination Fee ($2,450), made payable to "Treasurer of the United States" *(Mail to PVPO)*

17. DOES THE APPLICANT SPECIFY THAT SEED OF THIS VARIETY BE SOLD BY VARIETY NAME ONLY, AS A CLASS OF CERTIFIED SEED? *(See Section 83(a) of the Plant Variety Protection Act)*
☐ YES *(If "yes," answer items 18 and 19 below)* ☒ NO *(If "no," go to item 20)*

18. DOES THE APPLICANT SPECIFY THAT SEED OF THIS VARIETY BE LIMITED AS TO NUMBER OF GENERATIONS?
☒ YES ☐ NO

19. IF "YES" TO ITEM 18, WHICH CLASSES OF PRODUCTION BEYOND BREEDER SEED?
☐ FOUNDATION ☐ REGISTERED ☒ CERTIFIED

20. HAS THE VARIETY OR A HYBRID PRODUCED FROM THE VARIETY BEEN RELEASED, USED, OFFERED FOR SALE, OR MARKETED IN THE U.S. OR OTHER COUNTRIES?
☒ YES *(If "yes," give names of countries and dates)* ☐ NO
1999, United States

21. The applicant(s) declare that a viable sample of basic seed of the variety will be furnished with application and will be replenished upon request in accordance with such regulations as may be applicable, or for a tuber propagated variety a tissue culture will be deposited in a public repository and maintained for the duration of the certificate.

The undersigned applicant(s) is(are) the owner(s) of this sexually reproduced or tuber propagated plant variety, and believe(s) that the variety is new, distinct, uniform, and stable as required in Section 42, and is entitled to protection under the provisions of Section 42 of the Plant Variety Protection Act.

Applicant(s) is(are) informed that false representation herein can jeopardize protection and result in penalties.

SIGNATURE OF APPLICANT *(Owner(s))*		SIGNATURE OF APPLICANT *(Owner(s))*	
NAME *(Please print or type)* Leroy Mack		NAME *(Please print or type)*	
CAPACITY OR TITLE President	DATE 9/13/99	CAPACITY OR TITLE	DATE

INSTRUCTIONS

200 00065

GENERAL: To be effectively filed with the Plant Variety Protection Office (PVPO), ALL of the following items must be received in the PVPO: (1) Completed application form signed by the owner; (2) completed Exhibits A, B, C, E; (3) at least 2,500 viable untreated seeds, or for tuber reproduced varieties verification that a viable *(in the sense that it will reproduce an entire plant)* tissue culture will be deposited and maintained in an approved public repository; (4) check drawn on a U.S. bank for $2,450 ($300 filing fee and $2,150 examination fee), payable to "Treasurer of the United States" *(See Section 97.6 of the Regulations and Rules of Practice.)* Partial applications will be held in the PVPO for not more than 90 days, then returned to the applicant as unfiled. Mail application and other requirements to Plant Variety Protection Office, AMS, USDA, Room 500, NAL Building, 10301 Baltimore Blvd., Beltsville, MD 20705-2351. Retain one copy for your files. All items on the face of the application are self explanatory unless noted below. Corrections on the application form and exhibits must be initialed and dated. DO NOT use masking materials to make corrections. If a certificate is allowed, you will be requested to send a check payable to "Treasurer of the United States" in the amount of $300 for issuance of the Certificate.

Plant Variety Protection Office
Telephone: (301) 504-5518

ITEM

16a. Give: (1) the genealogy, including public and commercial varieties, lines, or clones used, and the breeding method;

(2) the details of subsequent stages of selection and multiplication;

(3) evidence of uniformity and stability; and

(4) the type and frequency of variants during reproduction and multiplication and state how these variants may be identified.

16b. Give a summary of the variety's distinctness. Clearly state how this application variety may be distinguished from all other varieties in the same crop. If the new variety is most similar to one variety or a group of related varieties:

(1) identify these varieties and state all differences objectively;

(2) attach statistical data for characters expressed numerically and demonstrate that these are clear differences;

(3) submit, if helpful, seed and plant specimens or photographs (prints) of seed and plant comparisons which clearly indicate distinctness.

16c. Exhibit C forms are available from the PVPO for most crops; specify crop kind. Fill in Exhibit C (Objective Description of Variety) form as completely as possible to describe your variety.

16d. Optional additional characteristics and/or photographs. Describe any additional characteristics that cannot be accurately conveyed in Exhibit C. Use comparative varieties as is necessary to reveal more accurately the characteristics that are difficult to describe, such as plant habit, plant color, disease resistance, etc.

16e. Section 52(5) of the Act requires applicants to furnish a statement of the basis of the applicant's ownership. An Exhibit E form is available from the PVPO.

17. If "Yes" is specified *(seed of this variety be sold by variety name only, as a class of certified seed)*, the applicant may NOT reverse this affirmative decision after the variety has been sold and so labelled, the decision published, or the certificate issued. However, if "No" has been specified, the applicant may change the choice. *(See Regulations and Rules of Practice, Section 97.103).*

20. See Sections 41, 42, and 43 of the Act and Section 97.5 of the regulations for eligibility requirements.

NOTES: It is the responsibility of the applicant/owner to keep the PVPO informed of any changes of address or change of ownership or assignment during the life of the application/certificate. There is no charge for filing a change of address. The fee for filing a change of ownership or assignment is specified in Section 97.175 of the regulations. *(See Section 101 of the Act, and Sections 97.130, 97.131, 97.175(h) of Regulations and Rules of Practice.)*

To avoid conflict with other variety names in use, the applicant should check the variety names proposed by contacting: Seed Branch, AMS, USDA, Room 213, Building 306, Beltsville Agricultural Research Center–East, Beltsville, MD 20705. Telephone: (301) 504-8089.

Item 16a. Exhibit A. Origin and Breeding History of the Variety

'Wrangler' is a winter-hardy seeded forage bermudagrass (Cynodon dactylon (L.) Pers.). 'Wrangler' is a six parent clone variety (2n=4X=36) derived from the interpollination of the lines designated: 40-6,42-12,47-5,53-13, and 57-9. Initially eight forage bermudagrass lines were obtained in a cooperative project between Johnston Seed Company and the Oklahoma Agricultural Experiment Station. The lines obtained in the cooperative project were developed through three cycles of phenotypic recurrent selection by Dr. Charles Taliaferro at the Agronomy Research Station located in Stillwater, Oklahoma. Dr. Taliaferro initially developed these breeding lines as described in Exhibit A – 1. Origin of Lines. Selection was based on winter hardiness, seed production potential (seed head prolificacy and percentage seed set) in Oklahoma, and dry matter production. The project entailed Johnston's Seed Company's participation in assisting in the evaluation of several lines of bermudagrass for commercial seed production. The eight lines obtained by Johnston Seed Company were progeny selected from a polycross designated BERPC 88-1. The lines were planted vegetatively from sod cut from nursery blocks at the Agronomy Research Station in July of 1991. The lines were planted at the Johnston Seed Company Research and Production Farm located in Enid, Oklahoma in non-replicated plots of 25 feet x 75 feet with plants spaced 3 feet apart (Exhibit A -Figure 1). In addition the lines were placed in a replicated seed yield test at the Agronomy Research Station in Stillwater by Dr. Taliaferro (Exhibit A - Figure 2). Seed yield was measured at the Agronomy Research Station in 1992 (Exibit A - Table 1), both sites in 1993, and Johnston's in 1994 and 1995 (Exhibit A -Table 2). All lines showed excellent winterhardiness in Oklahoma with no visible signs of winterkill since the initial planting in 1991. Dry matter production was visually determined to be acceptable based on the limited number of cold tolerant seeded varieties currently available. Results from the two locations indicated the lines could be produced economically for seed production in Oklahoma. The decision was made to eliminate the two lines 55-5 and 42-3. The line designated 55-5 showed susceptibility to foliar diseases and line 42-3 was slow in establishment and had lower seed production in the first years of the tests. In 1995 a formal agreement between Johnston Seed Company and the Oklahoma Agricultural Experiment Station was signed licensing this germplasm to Johnston Seed Company (Item 14e. Statement of the Basis of Applicant's Ownership). The remaining six lines were planted in large replicated blocks for further evaluation and increase at the Johnston Research and Production Farm in Enid, Oklahoma. The blocks were space planted three feet apart using 2.5 inch plugs obtained from the original plots planted on the Research and Production Farm. The individual blocks of each line were 25 feet x 400 feet (Exhibit A - Figure 3).

The production and sale of 'Wrangler' bermudagrass seed will be restricted to the F1 or Syn0 generation. The aforementioned nursery will be used as a sprig source for planting all production fields. Vegetative sprigs from all six clones will be harvested from this nursery, blended and planted to establish production fields. Due to this unique method of seed production there will be no advancing of generations beyond the Syn0 or F1 generation. All seed sold commercially will be the Syn0 or F1, therefore insuring uniformity and stability in the variety. All seed previously tested in forage trials, etc. is of the same generation of seed sold commercially, therefore all performance data collected should fully represent the potential of the variety. With the noted exceptions of a very low frequency of volunteer Syn0 seedlings, slight changes in clonal population, and the low frequency of the introduction of off-type plants into the fields, the seed produced from these fields will perform consistently over years. In contrast synthetic populations developed and produced in the Southwest United States begin with an initial seed population and advance the generations to increase the quantity of seed to expand the production acreage. This method greatly increases the risk of contamination, cross pollination, and genetic recombination resulting in varieties with increased variants and off-types. In addition, 'Wrangler' is produced in Northwest Oklahoma, a region with very limited bermdagrass seed production therefore reducing the risk of cross-pollination and cross-contamination. The method described above to produce 'Wrangler' insures the genetic integrity of seed for many years. Although this production method is more costly and slows varietal expansion, genetic integrity and longevity of the stand is greatly increased. As dictated by the method of varietal development, the seed production practices, and high self-incompatibility of these bermudagrass lines, variants occurring in the population would be substantially less than 0.1% of the population. After several years of plot and field observations, no obvious variants have been observed in any measurable frequency of the population.

Exhibit A – 1. Origin of Lines*

The clonal parents of Wrangler (BERPC88-1 40-6, BERPC88 42-3, BERPC88-1 42-12, BERPC88-1 47-5, BERPC88-1 48-5, BERPC88-1 55-5 and BERPC88-1 57-9) were selected from a *Cynodon dactylon* breeding population used for cyclic selection for increased seed production, adaptation, and turf or forage performance characteristics. The breeding population was developed in 1970 by field polycrossing several bermudagrass accessions in the Oklahoma State University *Cynodon* germplasm collection. The accessions were:

Acc #	PI	Origin
A8153		Afghanistan
A9945a	206427	Turkey
A9946a	206553	Greece
A9958	251809	Italy
A9959	253302	Yugoslavia
A10978b		Israel
A12156	223248	Guymon, OK

Three cycles of phenotypic recurrent selection (PRC) had been completed prior to selection of the Wrangler parental clonal plants in 1990.

*Information provided by Dr. Charles Taliaferro, Oklahoma State University

Table 1.

Seed Yield and Seed Quality of Forage Type Bermudagrass. Agronomy Research Station, 7100 Series. 1992-93.

Entry No.	Strain	1993 Pure Seed Yield	1993 Germination	1993 Pure Live Seed Yield	1992 Pure Seed Yield	1992-93 Mean Pure Seed Yield
		- lbs/acre -	- - - % - - -		- - - - - - - - - - lbs/acre - - - - - - - - - -	
1	40-6	313	79	249	279	296
2	42-3	174	65	126	117	146
3	42-12	322	82	266	268	295
4	45-5	297	78	233	404	350
5	48-5	455	80	373	248	352
6	53-13	313	79	249	203	258
7	55-5	341	69	240	323	332
8	57-9	453	87	387	237	345
Mean		334	77	265	259	297
LSD (5%)		171	14	155	134	102
CV (%)		35	12	40	35	34

Table 2.

Seed Yield of Forage Lines
1993-95
Johnston Seed Company Research and Production Farm

	Estimate Seed Yield lb./acre		
Entry	1993	1994	1995
40-6*	167.7	321.4	384.6
42-3	181.1	242.1	761.5
42-12*	178.4	727.7	340.9
47-5*	413.3	581.6	744.0
48-5*	446.6	498.5	493.3
53-13*	472.6	244.0	456.4
55-5	202.7	403.4	671.3
57-9*	231.2	406.4	466.8

* Lines used Wrangler

Figure 1.

Forage Lines from BERPC 88-1
Johnston Seed Company Research and Production Farm
42nd and Breckinridge Road
Enid, Oklahoma

Planting: 4 rows of plants spaced 3' apart in the rows
Plot Size: 25' x 75'
Planting Date: 8/91

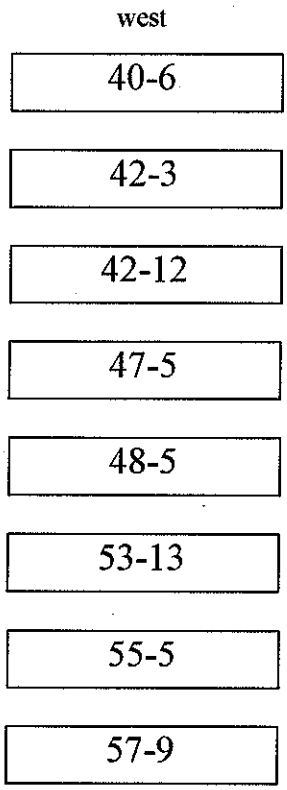


Figure 2.

FORAGE BERMUDAGRASS SEED YIELD TEST
7100 SERIES, AGRONOMY FARM

MATERIAL: PLANTS TAKEN FROM 4200 WEST USING CUT SOD; SELECTED PLANTS WERE PROGENY OF BERPC 88-1 IN CCB.
PLANTED: 7/23/91
EXP DESIGN: RCB WITH 4 REPLICATIONS, 8 ENTRIES
SPACING: 16' CENTERS AND 25' LONG PLOTS E-W
LOCATION: 20' NORTH OF GORDON TEST

E

48-5	53-13	42-3	42-12	57-9	47-5	55-5	40-6
57-9	40-6	55-5	53-13	48-5	42-3	47-5	42-12
42-3	40-6	48-5	42-12	47-5	55-5	57-9	53-13
53-13	42-12	47-5	55-5	57-9	42-3	40-6	48-5
1	2	3	4	5	6	7	8

N S

W

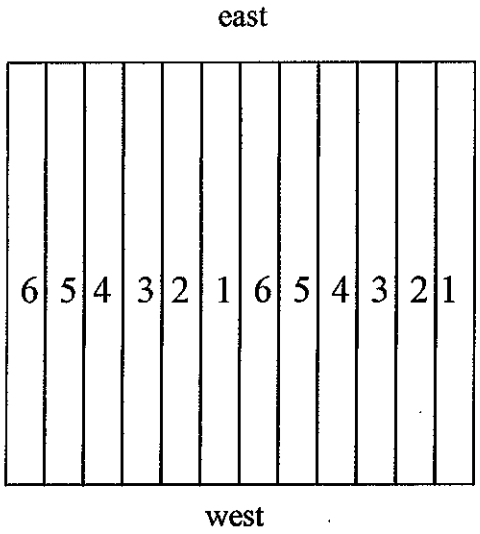
ENTRIES

1. 40-6
2. 42-3
3. 42-12
4. 47-5
5. 48-5
6. 53-13
7. 55-5
8. 57-9

Figure 3.

Selected Forage Lines from BERPC 88-1
Johnston Seed Company Research and Production Farm
42nd and Breckinridge Road
Enid, Oklahoma

Planting: 2.5" plugs space planted 3' apart
Plot Size: 25' x 400'of each line (8 rows of each)
Planting Date: 6/95



1. 40-6
2. 42-12
3. 48-5
4. 57-9
5. 47-5
6. 53-13

Item 16. Exhibit B. Statement of Distinctness

'Wrangler' is most similar to 'Cheyenne'; however, 'Wrangler' has shown significantly earlier spring greenup dates than 'Cheyenne'.

Item 16. Exhibit B-1 . Performance of Forage Bermudagrass Varieties in Oklahoma Tests, 1998-2001, , C.M. Taliaferro, G.L. Williams, T.G. Pickard, D.W. Hooper, and R.D. Kochenower, Oklahoma State University Fact Sheet PT 2002-3, 2001 data, p9, Table 10 - Haskelll, OK location.

Item 16. Exhibit B-2. Performance of Forage Bermudagrass Varieties in Oklahoma Tests, 1998-2002, C.M. Taliaferro, G.L. Williams, T.G. Pickard, D.W. Hooper, and R.D. Kochenower, Oklahoma State University Fact Sheet PT 2003-3, 2002 data, p10, Table 10 – Haskell, OK location.

Item 16. Exhibit B-3. Photographs of Relative greenup and growth of Arizona Common, Cheyenne, and Wrangler bermudagrasses. April 25, 2001 in Test 2000-1, Eastern Research Station, Haskell, OK.

Item 16. Exhibit B-4. Seeded Bermudagrass Variety Trial 2001, Virginia Tech University, Chris Teutsch and Mac Tilson, Southern Piedmont AREC, Blackstone, VA p7, Table 9. 2003 and 2004 Data.

Earlier spring greenup data historically indicates superior winter hardiness in bermudagrass varieties both turf and forage. 'Wrangler' and 'Guymon' have been successfully planted and survived with minimum winterkill to a line east and west along the 39 degrees North Lattitude (Interstate 70). 'Wrangler' plantings near Warrensburg, MO in the late 1990's are still producing with minimal winterkill. Common bermudagrasses planted in these areas thrive during the summer of establishment but have substantial winterkill with delayed greenup of surviving plants the following spring. The surviving plants if any are present will slowly recover over the summer and reestablish themselves. In the event of severe winters these stands will experience damage once again. In addition to the evidence of early greenup supplied above, included are various tests demonstrating the winter hardiness character of 'Wrangler' bermudagrass and its ability to survive and produce in the transition zone where other seeded types typically fail.

PRODUCTION TECHNOLOGY--CROPS

PERFORMANCE OF FORAGE BERMUDAGRASS VARIETIES IN OKLAHOMA TESTS, 1998-2001

C. M. Taliaferro, G. L. Williams, T. G. Pickard, D. W. Hooper, and R. D. Kochenower

Department of Plant and Soil Sciences, Division of Agricultural Sciences and Natural Resources, Oklahoma State University

BERMUDAGRASS, *Cynodon dactylon,* is widely used for pasture and hay over much of Oklahoma and the southern U.S.A. This introduced, perennial, sod-forming species serves as the principal forage base for many livestock enterprises because of its high forage production capability and the management flexibility that it provides. Bermudagrass varieties may differ in performance characteristics relating to establishment, adaptation, forage production and forage quality. Varieties that are poorly adapted to an area typically decline in stand density and productivity one or more years following establishment. Conversely, stands of well-adapted varieties will last indefinitely. Varieties also may differ substantially in forage production capability, and to a lesser degree, in forage quality characteristics. Consequently, deciding which bermudagrass variety to plant is important. To aid in selecting varieties, comparative performance data are reported from field tests conducted over the past few years. Data are also reported for experimental bermudagrass varieties included in performance testing.

DESCRIPTION OF THE TESTS

Forage yield data are reported from four field tests conducted at four sites. Locations and details of the tests are given in Table 1. Information about the bermudagrass varieties in the tests is given in Table 2. The recently released Midland 99 and Ozarka varieties were listed in earlier reports by their experimental designations 74X 21-6 and 74X 12-6, respectively. Plots in Tests 97-1, 98-1, and 98-2 were started by transplanting greenhouse-grown plants about 2 feet apart in each of two rows. The rows were spaced 2 feet apart equidistant from the center of the plot. Plots in Test 2000-1 were seeded at approximately 5 pure live seed pounds per acre, except for clonal standard varieties that were established in the previously described manner. Yield determinations were made by harvesting growth from an area about 3 feet in width and 10 to 15 feet in length through the middle of each plot. All tests were dryland except Test 97-1 at the Oklahoma Panhandle Research and Extension Center at Goodwell, OK. Test 97-1 was irrigated with approximately 6 acre-inches of water per month through the growing season. All tests received nitrogen fertilizer in the amount of 300 pounds N/acre/year, split into three applications of 100 pounds N/acre. The first application was made when the bermudagrasses initiated growth in the spring, usually in mid-April. The second and third fertilizer applications were made following the first and second harvests, respectively, which usually occurred in early June and early July. Soil pH, phosphorus, and potash levels were maintained at recommended levels based on soil test results. This fertilizer program provided a high yield environment in the absence of yield limiting factors such as low soil moisture, disease and winter injury. The high

yield environment was provided so that the bermudagrass varieties could express their genetic potential for forage yield.

RESULTS

Weather Data. Precipitation amounts received at the respective test sites during the reported test years (1998-2001) are given in Table 3. The 1998 through 2001 growing seasons had dry periods that reduced bermudagrass growth. Drought was particularly severe during July and August of 1998 and 1999 over the southern two-thirds of Oklahoma. The 1998-99 and 1999-2000 winters were mild resulting in minimal low temperature stress to the bermudagrass varieties. The 2000-2001 winter was the most severe experienced in Oklahoma in several years and resulted in substantially greater low temperature stress compared to the previous few winters.

Winter Survival. Visual ratings of early season growth (green-up) of bermudagrass varieties are given in Tables 4 (Test 97-1), 6 (Test 98-1), 8 (Test 98-2), and 10 (Test 2001-1). Differences among varieties in green-up following stressful winters generally are predictive of the relative cold tolerance of the varieties. However, differences among varieties in green-up may vary among locations because of variety by location interactions. The Goodwell test site typically has the coldest winters of the test locations. Green-up and growth of varieties in this test differed dramatically in spring 2001 (Table 4). Varieties initiating growth earliest were Guymon, Quickstand, Wrangler, LCB 84X 16-66, and LCB 84X 19-16.

All of the seeded bermudagrass varieties in Test 2001-1 at Haskell, except Guymon and Wrangler, had substantial winter injury. However, except for Giant, all of the varieties had enough surviving propagules to re-establish a full, or near full, sod cover by July. Giant had near total winter-kill, having only a few surviving propagules that ultimately emerged as new plants. The data suggest that KF 194 has relatively good cold tolerance in comparison to seeded common and similar varieties. The winter survival and early season growth response of CD90160 relative to other varieties differed between the Haskell and Goodwell sites. The Goodwell results suggested greater cold tolerance of CD90160 compared to the Haskell results.

Forage Yields. Forage yield data are given in Tables 5 (Test 97-1), 7 (Test 98-1), 9 (Test 98-2), and 11 (Test 2001-1). The relatively high average forage yields reflect the high yield environment management imposed on the tests. Bermudagrass varieties differed significantly ($P<0.05$) for forage yield in all tests and for all test years. In Test 97-1 at Goodwell, varieties with the highest 4-year yields were Ozarka, Hardie, LCB 84X 16-66, LCB 84X 19-16, and ERS 94X 2-8. The 2001 data from this test are especially useful in assessing relative variety performance in the northern zone of bermudagrass usage because they demonstrate the effects of winter stress. Varieties that began growth earliest generally had the highest yields at the first and second harvests. Some varieties with slow spring growth had recovered sufficiently by the third harvest to provide high yields. However, under practical use, winter injured varieties are subject to greater competition from weeds which accelerates stand decline over time.

In Test 98-1 at Haskell, the 3-year average forage yield of Midland 99 was greater than that of Tifton 44, which was greater than Greenfield (Table 7). The 3-year average yields in Test 98-2 for the three commercial varieties were Midland 99=Tifton 44>Greenfield. Midland 99 and

12

Tifton 44 yielded over 4 tons/acre/year more dry matter than Greenfield in Test 98-2. The experimental varieties ERS 94X 2-8, LCB 84X 19-16, and LCB 84X 16-66 have performed well in the three tests and will continue to be evaluated, particularly for sustained stand density and forage production.

Because of the extensive winter injury to most of the seeded bermudagrasses in Test 2001, the first harvest was not made until July 20 after all varieties except Giant had recovered a full, or near full, stand. Seeded variety forage yields in 2000 (establishment year) largely reflected differences in establishment rate. The varieties established at different rates due to differences in rapidity of seed germination, seedling growth, and rapidity of lateral spread through the season. In general, the seeded varieties established a ground cover more rapidly and made more growth than the clonal standard varieties as reflected in the yield differences reported for the August 24, 2000 harvest (Table 11). The most rapidly establishing varieties included common (variety not stated, Origin: Arizona), Tierra Verde, CD90160, Ranchero Frio, and Giant. The ground cover rates and forage yields of the very freeze tolerant Guymon and Wrangler were lower than those of most seeded varieties, and on a par with the vegetative standards. Guymon and Wrangler had forage yields equal to, or greater than, all other seeded varieties in 2001. The sprigged standards Midland 99, Tifton 44, and Ozarka yielded significantly less than some of the seeded varieties in 2000, but significantly more than all seeded varieties in 2001.

DISCUSSION

Bermudagrass varieties differ in important performance characteristics including establishment, forage yield, forage quality, and stand persistence. Of the reported commercial varieties, Midland has been grown in Oklahoma since the 1950's and is a proven dependable variety, particularly for central and western portions of the state. Greenfield, also released in the 1950's, has been grown most extensively in the eastern half of the state. Its popularity derives from good establishment capability and sustained productivity over many soil types and management conditions. In eastern Oklahoma, producers generally feel that Midland is suited for production on well-drained soils, but performs less well than Greenfield on finer textured soils that tend to be less well drained. Hardie has high yield potential and superior forage quality, but is limited by susceptibility to leaf spotting disease and intolerance to low soil pH (<5.5). Each of these conditions can result in stand thinning and loss of productivity of Hardie. Tifton 44 has high yield potential and relatively broad adaptation to the state. Midland 99 is a new variety indicated by extensive testing to have good adaptation to Oklahoma, high forage production potential, and good forage quality. Ozarka will enter the market in 2002 on the basis of extensive testing indicating it to have good adaptation to the northern part of the bermudagrass use zone, good stand persistence, and high forage yield capability.

Quickstand and Greenfield have excellent cold tolerance, aggressive establishment capability, and form dense sods. These are often referred to as "grazing type" varieties because of their shorter stature and denser sod relative to varieties like Midland, Midland 99, Tifton 44, and Ozarka, which are referred to as "hay types". The "grazing type" and the "hay type" varieties are used both for grazing and haying. The shorter stature "grazing type" varieties will typically spread faster during establishment and achieve a complete cover more rapidly than the named "hay type" varieties. However, once mature stands are achieved the "grazing type" varieties have lower forage yield potential than the "hay type" varieties. Mature stands of the more dense

"grazing type" varieties generally resist weed invasion to a greater extent than the less dense "hay type" varieties. Faster stands of varieties like Midland, Midland 99, Tifton 44, and Ozarka are usually achieved by planting 30 or more bushels of sprigs per acre in comparison to lower sprig planting rates.

The substantial differences among seeded bermudagrass varieties in cold tolerance and forage yield potential are important considerations for producers. Guymon and Wrangler have a level of cold tolerance sufficient for the northern part of the bermudagrass use zone. The other seeded bermudagrass varieties included in these tests have moderate to low freeze tolerance. The choices of using a seeded vs. clonal variety and which seeded variety to use should be made taking into account the average severity of winters for a given site and the forage yield goal. Seed of bermudagrass varieties is frequently blended in an attempt to combine the desirable traits of the different varieties. Such blends are usually sold under a brand name.

Table 1. Location and characteristics of the four bermudagrass tests from which data are reported herein.

Test 97-1	
Location	Oklahoma Panhandle Research and Extension Center, Goodwell, OK
Date Planted	June 3, 1997
Soil Type	Richfield clay loam
Treatments	19 varieties
Experimental Design	Randomized complete block, 4 replications
Irrigated or Dryland	Irrigated
Test 98-1	
Location	Eastern Research Station, Haskell, OK
Date Planted	May 12, 1998
Soil Type	Taloka silt loam
Treatments	12 varieties
Experimental Design	Randomized complete block, 4 replications
Irrigated or Dryland	Dryland
Test 98-2	
Location	South Central Research Station, Chickasha, OK
Date Planted	May 6, 1998
Soil Type	McLain silt loam
Treatments	12 varieties
Experimental Design	Randomized complete block, 4 replications
Irrigated or Dryland	Dryland
Test 2000-1	
Location	Eastern Research Station, Haskell, OK
Date Planted	May 17, 2000
Soil Type	Taloka silt loam
Treatments	12 varieties
Experimental Design	Randomized complete block, 4 replications
Irrigated or Dryland	Dryland

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Table 2. Information on commercial and experimental varieties included in bermudagrass tests.

Variety or Brand	Date Released	How Planted	Origin/Owner
COMMERCIAL VARIETIES - AVAILABLE FOR FARM USE			
CD90160	2000	Seed	Cebeco International Seeds, Halsey, OR
Cheyenne	1990	Seed	Seeds West, Roll, AZ
Common	--	Seed	Seeds West, Roll, AZ
Giant	--	Seed	Seeds West, Roll, AZ
Greenfield	1954	Sprigs	Oklahoma AES[1]
Guymon	1982	Seed	Oklahoma AES
Hardie	1974	Sprigs	Oklahoma AES
KF 194	2002	Seed	K-F Seeds, Brawley, CA
Midland	1953	Sprigs	Oklahoma AES & USDA-ARS[2]
Midland 99	1999	Sprigs	Oklahoma, Arkansas, Kansas, & Missouri AESs; USDA-ARS & Noble Foundation
Ozarka	2001	Sprigs	Missouri, Oklahoma, Arkansas & Kansas AESs; Noble Foundation & USDA-ARS
Quickstand	1993	Sprigs	Kentucky AES & USDA-NRCS[3]
Ranchero Fio[4]	--	Seed	Seeds West, Roll, AZ
Tierra Verde[5]	--	Seed	Seeds West, Roll, AZ
Tifton 44	1978	Sprigs	USDA-ARS & Georgia AES
Wrangler	1999	Seed	Johnston Seed Co., Enid, OK
EXPERIMENTAL VARIETIES -- NOT AVAILABLE FOR FARM USE			
A12199	NA	Sprigs	Oklahoma AES
ERS-C	NA	Sprigs	Oklahoma AES
SCRS-C	NA	Sprigs	Oklahoma AES
84X 16-66	NA	Sprigs	Oklahoma AES
84X 19-16	NA	Sprigs	Oklahoma AES
94X 2-8	NA	Sprigs	Oklahoma AES
94X 5-12	NA	Sprigs	Oklahoma AES
94X 6-13	NA	Sprigs	Oklahoma AES
94X 13-9	NA	Sprigs	Oklahoma AES

[1]AES=Agricultural Experiment Station. [2]ARS=Agricultural Research Service. [3]NRCS=Natural Resources Conservation Service. [4]Blend of Cheyenne and Giant seed. [5]Blend of Common and Giant seed.

Table 3. Precipitation amounts (inches) received by month for the test locations and test years.

Month	1998	1999	2000	2001	1998	1999	2000	2001
	ERS[1]				OPREC[2]			
January	4.91	2.62	0.71	4.20	0.10	0.73	0.20	0.47
February	0.63	2.25	1.52	4.97	0.70	0.05	0.05	1.04
March	5.17	5.05	4.03	0.89	1.69	1.96	5.39	1.82
April	2.25	8.86	3.20	2.19	0.81	4.77	1.93	1.00
May	3.70	11.07	1.53	9.13	0.73	1.82	1.01	1.09
June	3.08	6.81	6.88	2.64	0.87	2.85	2.29	0.61
July	2.14	0.00	1.72	0.04	4.13	0.20	0.76	0.00
August	2.63	2.07	0.00	2.50	2.57	0.75	1.09	0.66
September	6.32	7.66	2.61	2.43	0.24	0.36	0.03	0.27
October	8.43	2.07	10.85	6.86	6.77	2.27	5.68	0.00
November	3.61	1.45	3.32	5.96	0.87	0.00	0.02	0.72
December	2.30	3.61	1.45	2.66	0.47	0.27	0.14	0.12
	SCRS[3]							
January	6.29	1.92	1.99	3.35				
February	0.54	1.29	3.05	2.87				
March	5.96	3.90	3.25	0.79				
April	4.11	6.61	3.96	0.71				
May	0.86	3.69	8.31	5.12				
June	2.10	4.66	9.20	0.61				
July	0.00	0.42	2.98	0.49				
August	0.68	1.98	0.00	3.39				
September	0.92	2.26	3.12	2.45				
October	3.82	2.06	5.30	1.56				
November	3.40	0.04	4.46	1.07				
December	1.58	3.35	1.26	1.19				

[1]Eastern Research Station, Haskell, OK; [2]Oklahoma Panhandle Research & Extension Center, Goodwell, OK; [3]South Central Research Station, Chickasha, OK.

Table 4. Visual ratings of early season growth of bermudagrass varieties in Test 97-1, Panhandle Research & Extension Center, Goodwell, OK.

	Spring Greenup - % Plot Area[1]							
	2000			2001				
Variety	4-10-00	4-17-00	4-24-00	4-16-01	4-23-01	4-30-01	5-8-01	5-15-01
Commercial Varieties – Available for Farm Use								
CD 90160	14	94	100	5	15	34	56	73
Hardie	5	65	100	9	34	80	91	100
Greenfield	5	58	88	10	31	79	91	98
Guymon	10	69	100	18	63	86	100	100
Midland	26	63	95	8	25	69	93	100
Midland 99	16	75	100	0	0	14	31	89
Tifton 44	10	64	94	0	3	18	44	63
Quickstand	15	88	100	21	56	90	100	100
Wrangler	13	50	100	25	69	98	100	100
Experimental Varieties – Not Available for Farm Use								
Ozarka	15	63	100	8	38	83	98	100
LCB 84X 16-66	24	94	100	25	76	100	100	100
LCB 84X 19-16	11	81	100	25	90	100	100	100
ERS 94X 2-8	13	90	100	0	0	5	10	18
ERS 94X 5-12	16	75	100	0	0	5	18	50
ERS 94X 6-13	0	29	83	3	3	11	14	18
ERS 94X 13-9	5	45	95	0	0	5	10	21
A12199	8	71	94	8	34	73	89	94
ERS-Common	15	69	95	14	38	81	95	100
SCRS-Common	20	94	100	10	28	66	95	100
Mean	13	70	97	10	32	58	70	80
CV (%)	67	28	8	51	35	20	15	16
5% LSD	12	27	NS	7	16	17	15	18

[1]Visually estimated percent of total plot area covered by new growth.

Table 5. Forage yields (tons dry matter/acre) of commercial and experimental bermudagrass varieties in Test 97-1, Oklahoma Panhandle Research and Extension Center, Goodwell, OK.

	1998	1999	2000	2001					4-Year
Variety	4 Harvests	4 Harvests	4 Harvests	6-5	7-2	8-7	9-11	Total	Avg.
Commercial Varieties Available for Farm Use									
Ozarka	11.84*	8.00*	9.94*	3.51*	2.53**	4.74*	3.76*	14.54*	11.08*
Hardie	12.99**	8.03*	7.98	2.91	2.06*	4.66*	3.58	13.21	10.55*
CD 90160	11.75*	6.85	7.56	1.72	2.45*	4.88*	4.26*	13.31	9.86
Midland 99	10.16	7.60*	8.53	1.78	2.44*	4.60*	4.17*	12.99	9.82
Midland	8.64	5.32	7.47	2.67	1.58	5.24**	2.36	11.85	8.32
Quickstand	9.86	5.77	6.04	2.41	1.32	3.93	3.08	10.74	8.10
Tifton 44	9.23	5.48	6.98	1.81	1.75	4.73*	2.05	10.34	8.01
Guymon	9.65	4.49	5.51	2.41	1.87	4.32*	2.57	11.17	7.71
Wrangler	10.00	4.59	5.55	2.87	1.65	3.73	2.00	10.25	7.60
Greenfield	8.91	4.18	5.24	1.32	2.12*	3.54	2.75	9.73	7.02
Experimental Varieties – Not Available for Farm Use									
LCB 84X 16-66	11.93*	8.60*	8.86	4.22**	2.53**	4.74*	4.58*	16.07**	11.37*
LCB 84X 19-16	11.59*	9.74**	8.51	4.22**	2.36*	4.90*	4.77*	16.25**	11.52**
ERS 94X 2-8	11.65*	8.99*	10.29**	0.77	2.19*	4.92*	5.22*	13.10	11.01*
ERS 94X 13-9	9.48	6.45	7.95	0.63	2.29*	4.85*	5.23**	13.00	9.22
SCRS-C	10.61	5.85	7.39	2.13	2.32*	4.21	2.77	11.43	8.82
ERS 94X 5-12	9.23	5.57	6.31	1.02	1.69	4.67*	3.64	11.02	8.03
ERS-C	8.82	4.76	5.50	2.08	1.84	3.28	2.55	9.75	7.21
A12199	7.61	5.03	5.20	1.56	1.73	3.65	3.01	9.95	6.95
ERS 94X 6-13	8.08	5.07	6.13	0.43	1.34	3.98	1.95	7.70	6.75
Mean	10.11	6.33	7.21	2.13	2.00	4.40	3.38	11.91	8.89
CV (%)	16.3	19.7	10.7	30.4	22.2	15.4	31.3	15.4	16.1
5% LSD	2.34	1.77	1.09	0.92	0.63	0.96	1.50	2.60	0.99

**Highest numerical value in column.

*Not significantly different from the highest value in the column based on 5% LSD.

Table 6. Visual ratings of early season growth of bermudagrass varieties in Test 98-1, Eastern Research Station, Haskell, OK. 2001.

Variety	% Greenup[1]		Plant Height (In)[2]		
	4/6/01	5/14/01	4/10/01	4/23/01	5/14/01
	-------- % of plot--------		----------inches----------		
Commercial Varieties Available for Farm Use					
Midland 99	58	95	3.25	5.00	6.00
Tifton 44	48	95	2.75	3.75	3.25
Greenfield	55	99	2.00	3.00	2.75
Experimental Varieties – Not Available for Farm Use					
ERS 94X 2-8	35	64	4.50	6.25	7.50
LCB 84X 19-16	91	95	5.25	8.50	13.00
LCB 84X 16-66	50	88	4.50	6.25	5.25
ERS 94X 13-9	33	93	2.50	3.75	3.25
ERS 94X 6-13	0	14	0.00	0.13	1.00
SCRS-C	43	100	2.50	3.00	2.50
ERS 94X 5-12	30	85	2.25	3.50	2.75
ERS-C	58	99	2.00	3.00	2.50
A12199	50	100	2.00	3.00	1.75
Mean	4 6	85	2.79	4.09	4.29
CV (%)	17.8	4.4	16.2	13.5	16.3
5 % LSD	11.73	5.43	0.65	0.79	1.00

[1]Visually estimated of percent of total plot area covered by new growth.
[2] Height of new plant growth in plots with living plants.

Table 7. Forage yields (tons dry matter/acre) of commercial and experimental bermudagrass varieties in Test 98-1, Eastern Research Station, Haskell, OK.

Variety	1999 4 harvests	2000 4 harvests	2001 Harvests				3 yr Avg.
			5/31	7/10	10/3	Total	
Commercial Varieties Available for Farm Use							
Midland 99	9.03*	8.47	1.37	2.36	3.65**	7.38**	8.29*
Tifton 44	7.57	7.93	0.80	2.22	2.63	5.65	7.05
Greenfield	6.52	5.65	0.52	1.94	1.23	3.69	5.29
Experimental Varieties – Not Available for Farm Use							
ERS 94X 2-8	10.24**	9.82**	0.76	1.95	3.28	5.99	8.68**
LCB 84X 19-16	8.71	9.16*	2.20**	2.30	2.61	7.11*	8.32*
LCB 84X 16-66	8.70	7.51	1.21	1.95	2.43	5.59	7.26
ERS 94X 13-9	7.09	7.93	0.63	2.26	3.49*	6.38	7.13
ERS 94X 6-13	7.76	7.62	0.06	2.91**	2.19	5.16	6.85
SCRS-C	6.83	7.17	0.90	2.24	2.65	5.79	6.59
ERS 94X 5-12	7.26	7.28	0.36	1.66	2.73	4.75	6.43
ERS-C	5.78	5.93	0.54	1.81	1.08	3.43	5.05
A12199	5.23	5.95	0.22	2.12	1.37	3.71	4.96
Mean	7.56	7.53	0.80	2.14	2.44	5.38	6.82
CV(%)	12.7	8.7	27.4	10.7	14.9	12.5	11.4
5% LSD	1.38	0.94	0.31	0.33	0.52	0.97	0.63

**Highest numerical value in column
*Not significantly different from the highest numerical value in the column based on 5% LSD

Table 8. Visual ratings or measurements of early season growth of bermudagrass varieties in Test 98-2, South Central Research Station, Chickasha, OK. 20001.

Variety	Greenup[1]		Plant Height[2]		Sod density[3]	
	3-28-01	4-11-01	3-28-01	4-11-01	3-28-01	4-11-01
	%		Inches		Rating	
Commercial Varieties –Available for Farm Use						
Midland 99	8	89	1.00	5.00	4.25	7.25
Tifton 44	30	97	1.00	5.50	6.50	9.00
Greenfield	15	90	1.00	3.50	8.00	7.25
Experimental Varieties - Not Available for Farm Use						
ERS 94X 2-8	8	48	1.00	8.50	2.50	2.75
LCB 84X 19-16	48	80	1.00	6.50	5.50	6.00
ERS 94X 13-9	2	59	1.00	4.75	5.00	4.50
SCRS-C	3	89	1.00	4.75	6.00	7.25
LCB 84X 16-66	19	60	1.00	6.50	6.00	5.00
ERS 94X 6-13	0	40	0.00	4.50	3.00	1.00
A12199	5	95	1.00	2.75	7.50	8.00
ERS 94X 5-12	2	60	0.50	4.50	4.75	4.25
ERS-C	2	89	0.75	4.75	7.75	7.75
Mean	12	75	0.85	5.13	5.56	5.83
CV (%)	76.1	13.2	25.1	22.7	14.5	24.4
5% LSD	12.78	14.13	0.31	1.67	1.16	2.05

[1]Visually estimated of percent of plot area with new growth.
[2]Height of new plant growth in plots with living plants.
[3]Rated from 0 to 9, with 9 being most dense.

Table 9. Forage yields (tons dry matter/acre) of commercial and experimental bermudagrass varieties in Test 98-2, South Central Research Station, Chickasha, OK.

Variety	1999	2000	2001 Harvests					3-Yr
	4 harvests	4 harvests	6/4	7/19	8/20	10/16	Total	Avg.
Commercial Varieties – Available for Farm Use								
Midland 99	13.11*	10.97*	3.10*	1.72*	2.83**	1.64*	9.28**	11.12**
Tifton 44	12.03	12.26**	3.27**	1.37*	1.73	1.28	7.65	10.65*
Greenfield	8.91	6.73	2.06	0.31	0.87	0.81	4.04	6.56
Experimental Varieties – Not Available for Farm Use								
ERS 94X 2-8	14.21**	10.31*	2.63*	1.86**	2.77*	1.42*	8.68*	11.06*
LCB 84X 19-16	11.72	10.10*	2.80*	1.85*	1.96	1.81**	8.41*	10.08*
ERS 94X 13-9	10.95	10.36*	2.90*	1.53*	2.45*	1.64*	8.53*	9.94
SCRS-C	11.69	10.40*	2.81*	0.81	2.44*	1.29	7.35	9.81
LCB 84X 16-66	13.00*	7.46	2.60	0.49	1.55	1.44*	6.08	8.85
ERS 94X 6-13	10.43	8.90	2.21	0.79	1.78	1.43*	6.20	8.51
A12199	8.56	7.21	2.03	0.73	1.77	1.51*	6.03	7.26
ERS 94X 5-12	9.01	6.82	1.72	0.89	1.81	1.31	5.72	7.18
ERS-C	8.81	4.98	1.38	0.32	0.83	0.79	3.32	5.70
Mean	11.03	8.87	2.46	1.06	1.90	1.36	6.77	8.89
CV (%)	12.9	18.0	18.2	35.1	21.4	20.8	14.3	15.2
5% LSD	2.05	2.30	0.64	0.53	0.58	0.41	1.39	1.10

**Highest numerical value in column
*Not significantly different from the highest numerical value in the column based on 5% LSD

Table 10. Visual ratings or measurements of early season growth of bermudagrass varieties in Test 2000-1, Eastern Research Station, Haskell, OK. 2001.

Variety	% Greenup[1]		Plant Height (In)[2]		
	4-6-01	5-15-01	4-10-01	4-23-01	5-15-01
Seeded Varieties					
Common	8	24	0.75	0.00	1.25
Tierra Verde	0	4	0.00	0.25	0.75
CD 90160	6	29	0.75	0.00	1.25
Ranchero Frio	4	5	0.25	0.00	1.00
Giant	0	0	0.00	0.00	0.00
Cheyenne	8	28	1.00	0.00	1.25
Guymon	89	93	2.50	4.00	3.75
Wrangler	94	96	2.75	4.00	4.50
KF 194	23	66	1.50	1.00	1.50
Clonal Standard Varieties					
Midland 99	93	98	2.50	4.50	9.50
Tifton 44	93	95	3.00	5.50	7.25
Ozarka	55	80	2.25	5.50	5.00
Mean	39	51	1.44	2.06	3.08
CV (%)	21.8	19.8	26.2	25.3	31.7
5% LSD	12.29	14.63	0.54	0.75	1.41

[1]Visually estimated of percent of total plot area with new growth.
[2]Height of new plant growth in plots with living plants.

Table 11. Forage yields (tons dry matter/acre) of commercial and experimental bermudagrass varieties in Test 2000-1, Eastern Research Station, Haskell, OK.

Variety	2000 Harvests			2001 Harvests[1]			2-Yr Avg.
	8/24	10/9	Total	7/20	10/3	Total	
Seeded Varieties							
Common	5.36**	0.00	5.36*	4.28	2.15	6.43	5.89
Tierra Verde	5.10*	0.70**	5.79**	2.65	2.74	5.39	5.59
CD 90160	5.00*	0.00	5.00	4.05	2.06	6.11	5.55
Ranchero Frio	4.59	0.65*	5.23*	3.71	2.51	6.22	5.72
Giant[2]	4.34	0.68*	5.01	---	---	---	---
Cheyenne	3.78	0.39	4.17	4.70	2.55	7.26	5.71
Guymon	3.50	0.00	3.50	5.38*	2.28	7.66	5.58
Wrangler	3.07	0.00	3.07	5.08	2.29	7.37	5.22
KF 194	5.35*	0.00	5.35*	5.00	2.19	7.19	6.27
Clonal Standard Varieties							
Midland 99	4.05	0.26	4.32	5.69**	3.74**	9.44**	6.88**
Tifton 44	3.81	0.00	3.81	5.24*	3.00	8.24	6.03
Ozarka	3.38	0.00	3.38	5.28*	3.68*	8.96*	6.17
Mean	4.28	0.22	4.50	4.64	2.65	7.29	5.87
CV (%)	9.0	44.71	8.95	9.1	9.8	7.5	8.2
5% LSD	0.55	0.14	0.58	0.61	0.38	0.78	0.48

[1]Winter injury to most seeded bermudagrass varieties resulted in delayed 1st harvest.
[2]Did not recover sufficiently from winter injury to harvest
**Highest numerical value in columns.
*Not significantly different from the highest numerical value in the column based on 5% LSD.

Additional information on forage bermudagrass and related topics is contained in these publications available from your Cooperative Extension Office:

PT 2001-9	Performance of Forage Bermudagrass Varieties in Oklahoma Tests, 1998-2000.
PT 2000-8	Performance of Forage Bermudagrass Varieties in Oklahoma Tests, 1995-99.
PT 96-9	Performance Of Forage Bermudagrass Varieties In Oklahoma Tests, 1992-1995.
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PRODUCTION TECHNOLOGY--CROPS

PERFORMANCE OF FORAGE BERMUDAGRASS VARIETIES IN OKLAHOMA TESTS, 1998-2002

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BERMUDAGRASS, *Cynodon dactylon* (L.) Pers., is used for pasture and hay over much of the southern USA. This introduced, perennial, sod-forming grass serves as the principal forage base for many livestock enterprises because of its high forage production capability and the management flexibility that it provides. Bermudagrass varieties may differ in performance characteristics relating to establishment, adaptation, forage production and forage quality. Varieties that are poorly adapted to an area decline in stand density and productivity one or more years following establishment. Conversely, stands of well-adapted varieties will last indefinitely. Varieties also may differ substantially in forage production capability, and to a lesser degree, in forage quality characteristics. Consequently, deciding which bermudagrass variety to plant is important. To aid in selecting varieties, comparative performance data are reported from field tests conducted over the past few years. Data are also reported for experimental bermudagrass varieties included in performance testing.

DESCRIPTION OF THE TESTS

Forage yield data are reported from six field tests conducted at three sites. Locations and details of the tests are given in Table 1. Information about the bermudagrass varieties in the tests is given in Table 2. The recently released Midland 99 and Ozark varieties were listed in reports preceding their release by their experimental designations 74X 21-6 and 74X 12-6, respectively. Plots in Tests 1997-1, 1998-1, 1998-2, 2001-1 and 2001-2 were started by transplanting greenhouse-grown plants about 2 feet apart in each of two rows. The rows were spaced 2 feet apart equidistant from the center of the plot. Plots in Test 2000-1 were seeded at approximately 5 pure live seed pounds per acre, except for clonal standard varieties that were established in the previously described manner. Yield determinations were made by harvesting growth from an area about 3 feet in width and 10 to 15 feet in length through the middle of each plot. All tests were dryland except Test 1997-1 at the Oklahoma Panhandle Research and Extension Center at Goodwell, OK. Test 1997-1 was irrigated with approximately six acre-inches of water per month through the growing season. All tests received nitrogen fertilizer in the amount of 300 pounds N/acre/year, split into three applications of 100 pounds N/acre. Nitrogen was first applied when the bermudagrasses initiated growth in the spring, usually in mid-April. The second and third N applications followed the first and second harvests, respectively, which usually occurred in early June and early July. Soil pH, phosphorus, and potash levels were maintained at recommended levels based on soil test results. This fertilizer program provided a high yield environment in the absence of yield limiting factors such as low soil moisture, disease

and winter injury. The high yield environment was provided so that the bermudagrass varieties could express their genetic potential for forage yield.

RESULTS

Weather Data. Precipitation amounts received at the respective test sites during the reported test years (1998-2002) are given in Table 3. Precipitation during the 2002 growing season at the Chickasha and Haskell dryland sites was relatively high and well distributed. Dry periods during the growing season occurred at each of these sites in years prior to 2002 resulting in reduced growth of the bermudagrasses. However, prolonged severe drought has not occurred at either site over the duration of the tests. Severity of winters has been mild to average. The 1998-99 and 1999-2000 winters were mild resulting in minimal low temperature stress to the bermudagrass varieties. The severity of the 2000-2001 and 2001-2002 winters was closer to normal, resulting in substantially greater low-temperature stress to plants compared to the previous few winters.

Winter Survival. Visual ratings of 2002 early-season growth (green-up) of bermudagrass varieties are given in Tables 4 (Test 1997-1), 6 (Test 1998-1), 8 (Test 1998-2), and 10 (Test 2001-1). Differences among varieties in date and rate of green-up following stressful winters generally are predictive of the relative cold tolerance of the varieties. However, differences among varieties in green-up may vary among locations because of variety by location interactions. The Goodwell test site typically has the coldest winters of the test locations. Green-up and growth of varieties in this test differed dramatically in spring 2002 (Table 4) following patterns of previous spring green-up. Varieties that have initiated growth earliest at Goodwell are Guymon, Quickstand, Wrangler, LCB 84X 16-66, and LCB 84X 19-16.

All of the seeded bermudagrass varieties in Test 2001-1 at Haskell, except Guymon and Wrangler, have consistently had substantial winter injury. However, all of the injured varieties have had enough surviving propagules to re-establish a full, or near full, stand by July. Giant bermudagrass, initially included in the test, had near total winterkill during the first winter (2000-2001) and was discontinued in the test. The winter survival and early season growth response of CD90160 in Tests 1997-1 at Goodwell and 2000-1 at Haskell differed between the sites. Its survival at Goodwell suggested greater cold tolerance compared to the Haskell results.

Forage Yields. Forage yield data are given in Tables 5 (Test 1997-1), 7 (Test 1998-1), 9 (Test 1998-2), 11 (Test 2000-1), 13 (Test 2001-1), and 14 (Test 2001-2). The high average forage yields reflect the high yield environment management imposed on the tests. Bermudagrass varieties differed significantly ($P<0.05$) for forage yield in all tests and for all test years. In Test 1997-1 at Goodwell, Commercial varieties with the highest 5-year average yields were Ozark, Hardie, and Midland 99. The experimental varieties at Goodwell with the highest 5-year average yields were 84X 16-66, LCB 84X 19-16, and ERS 94X 2-8. In Test 1998-1 at Haskell, the 4-year average forage yield of Midland 99 was greater than that of Tifton 44, which was greater than Greenfield (Table 7). The 4-year average yields in Test 1998-2 for the three commercial varieties were Midland 99=Tifton 44>Greenfield. Midland 99 and Tifton 44 have yielded approximately 4 tons/acre/year more dry matter than Greenfield in Test 1998-2. The experimental varieties ERS 94X 2-8, LCB 84X 19-16, and LCB 84X 16-66 have performed well

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in Tests 1997-1, 1998-1, and 1998-2, and will continue to be evaluated for sustained stand density and forage production.

Extensive winter injury to most of the seeded bermudagrasses in Test 2001 has delayed their first harvest until late June or July of each year. Guymon and Wrangler have consistently had superior early green-up and growth compared to the other seeded varieties, but 3-year average seasonal total yields of the seeded varieties are similar. It is important to note that weeds were controlled in the test to the extent that severe competition did not result and prevent the injured bermudagrasses in re-establishing full stands. Some weeds, mainly crabgrass, did invade the winter injured bermudagrass plots, particularly in May and June of each year. The reported yields of these varieties are inflated accordingly. The Midland 99, Tifton 44, and Ozark sprigged standard varieties in Test 2000-1 yielded significantly less than some of the seeded varieties in year 2000, but yielded significantly more than all seeded varieties in years 2001 and 2002.

Differences in initial establishment rate of the seeded varieties compared to the sprigged standard varieties in the test were discussed in reports PT 2001-9 and PT 2002-3. The seeded varieties established a ground cover more rapidly and made more growth than the clonal standard varieties in the establishment year. The most rapidly establishing varieties were common (variety not stated, Origin: Arizona), Tierra Verde, CD90160, Ranchero Frio, and Giant. The ground cover rates and forage yields of the very freeze tolerant Guymon and Wrangler were lower than those of most seeded varieties during the establishment year, and on a par with the vegetative standards.

DISCUSSION

Of the reported commercial varieties, Midland has been grown in Oklahoma since the 1950's and is a proven dependable variety, particularly for central and western portions of the state. Greenfield, also released in the 1950's, has been grown most extensively in the eastern half of the state. Its popularity stems from good establishment capability and sustained productivity over many soil types and management conditions. In eastern Oklahoma, producers generally feel that Midland is suited for production on well-drained soils, but performs less well than Greenfield on finer textured soils that tend to be less well drained. Hardie has high yield potential and superior forage quality, but is limited by susceptibility to leaf spotting disease and intolerance to low soil pH (<5.5). Each of these conditions can result in stand thinning and loss of productivity of Hardie. Tifton 44 has high yield potential and relatively broad adaptation to the state. Midland 99 is a new variety indicated by extensive testing to have good adaptation to Oklahoma, high forage production potential, and good forage quality. Ozark's scheduled market entrance in 2002 was delayed, but Foundation class sprigs will be offered in 2003. Extensive testing indicates Ozark to have good adaptation to the northern part of the bermudagrass use zone, good stand persistence, and high forage yield capability.

Quickstand and Greenfield have excellent cold tolerance, aggressive establishment capability, and form dense sods. These are often referred to as "grazing type" varieties because of their shorter stature and denser sod relative to varieties like Midland, Midland 99, Tifton 44, and Ozark, which are referred to as "hay types". The "grazing type" and the "hay type" varieties are used both for grazing and haying. The shorter stature "grazing type" varieties will typically spread faster during establishment and achieve a complete cover more rapidly than the named

"hay type" varieties. However, once mature stands are achieved the "grazing type" varieties have lower forage yield potential than the "hay type" varieties. The greater yield potential of the "hay type" varieties compared to the "grazing type" varieties is realized to the greatest extent in high yield environments. Mature stands of the more dense "grazing type" varieties generally resist weed invasion to a greater extent than the less dense "hay type" varieties. Faster stands of varieties like Midland, Midland 99, Tifton 44, and Ozark are usually achieved by planting 30 or more bushels of sprigs per acre in comparison to lower sprig planting rates.

The substantial differences among seeded bermudagrass varieties in cold tolerance and forage yield potential are important considerations for producers. Guymon and Wrangler have a level of cold tolerance sufficient for the northern part of the bermudagrass use zone. The other seeded bermudagrass varieties included in these tests have moderate to low freeze tolerance. The choices of using a seeded vs. clonal variety and which seeded variety to use should be made taking into account the average severity of winters for a given site and the forage yield goal. Seed of bermudagrass varieties is frequently blended in an attempt to combine the desirable traits of the different varieties. Such blends are usually sold under a brand name.

Table 1. Location and characteristics of the bermudagrass tests from which data are reported herein.

	Test 1997-1
Location	Oklahoma Panhandle Research and Extension Center, Goodwell, OK
Date Planted	June 3, 1997
Soil Type	Richfield clay loam
Treatments	19 varieties
Experimental Design	Randomized complete block, 4 replications
Irrigated or Dryland	Irrigated
	Test 1998-1
Location	Eastern Research Station, Haskell, OK
Date Planted	May 12, 1998
Soil Type	Taloka silt loam
Treatments	12 varieties
Experimental Design	Randomized complete block, 4 replications
Irrigated or Dryland	Dryland
	Test 1998-2
Location	South Central Research Station, Chickasha, OK
Date Planted	May 6, 1998
Soil Type	McLain silt loam
Treatments	12 varieties
Experimental Design	Randomized complete block, 4 replications
Irrigated or Dryland	Dryland
	Test 2000-1
Location	Eastern Research Station, Haskell, OK
Date Planted	May 17, 2000
Soil Type	Taloka silt loam
Treatments	12 varieties
Experimental Design	Randomized complete block, 4 replications
Irrigated or Dryland	Dryland
	Test 2001-1
Location	Eastern Research Station, Haskell, OK
Date Planted	May 16, 2001
Soil Type	Taloka silt loam
Treatments	17 varieties
Experimental Design	Randomized complete block, 4 replications
Irrigated or Dryland	Dryland
	Test 2001-2
Location	South Central Research Station, Chickasha, OK
Date Planted	May 24, 2001
Soil Type	McLain silt loam
Treatments	17 varieties
Experimental Design	Randomized complete block, 4 replications
Irrigated or Dryland	Dryland

Table 2. Information on commercial and experimental varieties included in bermudagrass tests.

Variety or Brand	Date Released	How Planted	Origin/Owner
COMMERCIAL VARIETIES - AVAILABLE FOR FARM USE			
CD90160	2000	Seed	Cebeco International Seeds, Halsey, OR
Cheyenne	1990	Seed	Seeds West, Roll, AZ
Common	--	Seed	Seeds West, Roll, AZ
Greenfield	1954	Sprigs	Oklahoma AES[1]
Guymon	1982	Seed	Oklahoma AES
Hardie	1974	Sprigs	Oklahoma AES
KF 194	2002	Seed	K-F Seeds, Brawley, CA
Midland	1953	Sprigs	Oklahoma AES & USDA-ARS[2]
Midland 99	1999	Sprigs	Oklahoma, Arkansas, Kansas, & Missouri AESs; USDA-ARS & Noble Foundation
Ozark	2001	Sprigs	Missouri, Oklahoma, Arkansas & Kansas AESs; Noble Foundation & USDA-ARS
Quickstand	1993	Sprigs	Kentucky AES & USDA-NRCS[3]
Ranchero Fio[4]	--	Seed	Seeds West, Roll, AZ
Tierra Verde[5]	--	Seed	Seeds West, Roll, AZ
Tifton 44	1978	Sprigs	USDA-ARS & Georgia AES
Wrangler	1999	Seed	Johnston Seed Co., Enid, OK
EXPERIMENTAL VARIETIES – NOT AVAILABLE FOR FARM USE			
A12199	NA	Sprigs	Oklahoma AES
A12244	NA	Sprigs	Oklahoma AES
A12245	NA	Sprigs	Oklahoma AES
A12246	NA	Sprigs	Oklahoma AES
ERS-C	NA	Sprigs	Oklahoma AES
ERS 16S-1	NA	Sprigs	Oklahoma AES
ERS 16S-2	NA	Sprigs	Oklahoma AES
ERS 16S-3	NA	Sprigs	Oklahoma AES
ERS 16S-4	NA	Sprigs	Oklahoma AES
ERS 16S-5	NA	Sprigs	Oklahoma AES
ERS 16S-6	NA	Sprigs	Oklahoma AES
ERS 16S-7	NA	Sprigs	Oklahoma AES
ERS 16S-8	NA	Sprigs	Oklahoma AES
ERS 16S-9	NA	Sprigs	Oklahoma AES
ERS 16S-10	NA	Sprigs	Oklahoma AES
SCRS-C	NA	Sprigs	Oklahoma AES
LCB 84X 16-66	NA	Sprigs	Oklahoma AES
LCB 84X 19-16	NA	Sprigs	Oklahoma AES
ERS 94X 2-8	NA	Sprigs	Oklahoma AES
ERS 94X 5-12	NA	Sprigs	Oklahoma AES
ERS 94X 6-13	NA	Sprigs	Oklahoma AES
ERS 94X 13-9	NA	Sprigs	Oklahoma AES

[1]AES=Agricultural Experiment Station. [2]ARS=Agricultural Research Service. [3]NRCS=Natural Resources Conservation Service. [4]Blend of Cheyenne and Giant seed. [5]Blend of Common and Giant seed.

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Table 3. Precipitation amounts (inches) received by month for the test locations and test years.

Month	1998	1999	2000	2001	2002	1998	1999	2000	2001	2002
	ERS[1]					OPREC[2]				
January	4.91	2.62	0.71	4.20	2.41	0.10	0.73	0.20	0.47	0.22
February	0.63	2.25	1.52	4.97	0.80	0.70	0.05	0.05	1.04	0.36
March	5.17	5.05	4.03	0.89	3.12	1.69	1.96	5.39	1.82	0.00
April	2.25	8.86	3.20	2.19	4.46	0.81	4.77	1.93	1.00	0.52
May	3.70	11.07	1.53	9.13	8.70	0.73	1.82	1.01	1.09	2.06
June	3.08	6.81	6.88	2.64	2.32	0.87	2.85	2.29	0.61	1.37
July	2.14	0.00	1.72	0.04	3.46	4.13	0.20	0.76	0.00	2.63
August	2.63	2.07	0.00	2.50	3.54	2.57	0.75	1.09	0.66	0.28
September	6.32	7.66	2.61	2.43	1.14	0.24	0.36	0.03	0.27	2.46
October	8.43	2.07	10.85	6.86	4.18	6.77	2.27	5.68	0.00	3.41
November	3.61	1.45	3.32	5.96	1.03	0.87	0.00	0.02	0.72	0.11
December	2.30	3.61	1.45	2.66	3.76	0.47	0.27	0.14	0.12	0.89
	SCRS[3]									
January	6.29	1.92	1.99	3.35	2.23					
February	0.54	1.29	3.05	2.87	0.89					
March	5.96	3.90	3.25	0.79	1.98					
April	4.11	6.61	3.96	0.71	4.97					
May	0.86	3.69	8.31	5.12	2.12					
June	2.10	4.66	9.20	0.61	4.03					
July	0.00	0.42	2.98	0.49	3.18					
August	0.68	1.98	0.00	3.39	1.67					
September	0.92	2.26	3.12	2.45	3.32					
October	3.82	2.06	5.30	1.56	8.05					
November	3.40	0.04	4.46	1.07	0.49					
December	1.58	3.35	1.26	1.19	2.35					

[1]Eastern Research Station, Haskell, OK; [2]Oklahoma Panhandle Research & Extension Center, Goodwell, OK;
[3]South Central Research Station, Chickasha, OK.

Table 4. Ratings of spring green-up for Bermudagrass Varieties in Test 1997-1, Panhandle Research & Extension Center, Goodwell, OK. 2002.

Variety	% Green-up[1] 4/15	4/22	4/29	5/7
Commercial Varieties – Available for Farm Use				
Greenfield	5	40	74	93*
Guymon	8	44	80	93*
Hardie	13	63*	92*	93*
Midland	18*	63*	95*	98*
Midland 99	0	28	58	79
Ozarka	11	56*	85*	98*
Quickstand	8	31	74	90*
Tifton 44	8	44	80	84
Wrangler	18*	56*	85*	95*
Experimental Varieties – Not Available for Farm Use				
A12199	5	34	66	88*
CD90160	11	40	68	68
ERS-C	5	28	81*	98*
ERS 94X 2-8	3	34	76	88*
ERS 94X 5-12	3	14	64	64
ERS 94X 6-13	3	9	28	31
ERS 94X 13-9	3	18	56	70
LCB 84X 16-66	25**	75**	98**	100**
LCB 84X 19-16	18*	69*	98**	100**
SCRS-C	15*	44	85*	93*
Avg.	9	41	76	85
CV (%)	80	42	16	11
5% LSD	10	24	17	14

[1]Visually estimated percent of total plot area with new growth
**Highest numerical value in column
*Not significantly different from the highest numerical value in the column based on 5% LSD

Table 5. Forage yields (tons dry matter/acre) of commercial and experimental bermudagrass varieties in Test 1997-1, Oklahoma Panhandle Research and Extension Center, Goodwell, OK. 1998-2002.

Variety	2002 Harvests 6/11	7/10	8/6	9/8	Total	5-Year Avg.
Commercial Varieties – Available for Farm Use						
Ozark	4.18*	3.11*	2.54	3.43*	13.25*	11.51*
Hardie	2.69	2.53*	2.41	3.32	10.94	10.63
Midland 99	2.60	3.51*	3.13*	3.63*	12.86*	10.43
Midland	2.55	3.64*	2.59	3.29	12.06	9.07
Tifton 44	2.50	2.77	2.56	3.16	10.99	8.60
Guymon	3.48	3.03*	1.93	3.17	11.60	8.48
Wrangler	3.67	2.46	1.83	3.80*	11.76	8.43
Quickstand	2.25	2.07	1.55	3.31	9.17	8.32
Greenfield	3.13	2.92*	1.66	3.16	10.86	7.78
Experimental Varieties – Not Available for Farm Use						
LCB 84X 16-66	4.76**	2.42	3.28*	4.05*	14.51*	11.99**
LCB 84X 19-16	4.59*	3.09*	2.73*	3.48*	13.89*	11.99**
ERS 94X 2-8	3.48	3.75**	3.06*	4.51**	14.80**	11.76*
CD 90160	4.11*	2.96*	2.49	4.11*	13.67*	10.62
ERS 94X 13-9	3.07	3.21*	2.77*	4.26*	13.30*	10.03
SCRS-C	3.62	1.78	1.51	4.08*	10.98	9.25
ERS 94X 5-12	1.97	3.22*	3.39**	3.72*	12.29	8.88
ERS-C	2.99	2.98*	2.11	2.92	11.00	7.97
A-12199	2.29	2.61*	1.70	3.34	9.94	7.55
ERS 94X 6-13	1.00	2.56*	1.69	3.80*	9.04	7.20
Avg.	3.10	2.87	2.36	3.60	11.94	9.50
CV (%)	23.5	30.4	23.6	22.7	12.6	15.3
5% LSD	1.03	1.24	0.79	1.16	2.14	0.90

**Highest numerical value in column
*Not significantly different from the highest numerical value in the column based on 5% LSD

Table 6. Visual ratings or measurements of early-season growth of bermudagrass varieties in Test 1998-1, Eastern Research Station, Haskell, OK. 2002.

Variety	Green-up[1] 5/21/02	Plant Height[2] 4/12/02	5/21/02
	--------%--------	----------Inches----------	
Commercial Varieties – Available for Farm Use			
Midland 99	98.75*	1.00*	16.75
Tifton 44	93.75*	0.83	12.50
Greenfield	100.00**	1.25*	11.25
Experimental Varieties – Not Available for Farm Use			
ERS 94X 2-8	63.75	2.75*	19.25*
LCB 84X 19-16	100.00**	3.00**	21.75**
LCB 84X 16-66	86.25	1.75*	12.50
ERS 94X 13-9	80.00	1.00*	10.00
ERS 94X 6-13	38.75	0.38	3.75
SCRS-C	100.00**	1.25*	13.00
ERS 94X 5-12	86.25	0.75	9.25
ERS-C	100.00**	1.00*	12.50
A12199	100.00**	0.88	6.50
Avg.	87.29	1.33	12.4
CV (%)	5.4	30.2	15.6
5% LSD	6.83	2.04	2.78

**Highest numerical value in column
*Not significantly different from the highest numerical value in the column based on 5% LSD
[1]Visually estimated percent of total plot area covered by new growth
[2]Height of new plant growth in plots with growing plants

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Table 7. Forage yields (tons dry matter/acre) of commercial and experimental bermudagrass varieties in Test 1998-1, Eastern Research Station, Haskell, OK. 1999-2002.

	2002 Harvests					4-Yr
	5/22	6/26	8/08	11/06	Total	Avg.
Commercial Varieties – Available for Farm Use						
Midland 99	1.65	2.62*	3.32*	1.15*	8.73**	8.40*
Tifton 44	1.16	2.68*	3.21*	0.78	7.82*	7.24
Greenfield	1.66*	1.91	2.13	0.41	6.10	5.49
Experimental Varieties – Not Available for Farm Use						
ERS 94X 2-8	1.21	2.42*	2.90	1.39**	7.91*	8.49**
LCB 84X 19-16	1.96*	2.34	3.03*	1.23*	8.56*	8.38*
ERS 94X 13-9	0.99	2.71**	3.33**	0.93	7.95*	7.33
LCB 84X 16-66	1.08	2.22	2.33	1.13*	6.76	7.14
SCRS-C	2.10**	2.33	2.83	0.40	7.66	6.86
ERS 94X 5-12	0.93	2.50*	3.24*	0.94	7.61	6.72
ERS 94X 6-13	0.10	2.46*	2.72	0.83	6.11	6.66
ERS-C	1.90*	2.00	2.12	0.44	6.46	5.40
A12199	0.88	2.04	2.67	0.41	6.00	5.22
Avg.	1.30	2.35	2.82	0.84	7.30	6.94
CV (%)	23.7	9.6	7.3	33.3	9.0	10.6
5% LSD	0.44	0.32	0.30	0.40	0.94	0.51

**Highest numerical value in column
*Not significantly different from the highest numerical value in the column based on 5% LSD

Table 8. Visual ratings or measurements of early-season growth of bermudagrass varieties in Test 1998-2, South Central Research Station, Chickasha, OK. 2002.

Variety	Green-up[1]			Plant Height[2]			Sod density[3]		
	4/2/02	4/15/02	4/24/02	4/2/02	4/15/02	4/24/02	4/2/02	4/15/02	4/24/02
	%			Inches			Rating		
Commercial Varieties - Available for Farm Use									
Midland 99	1.00	75.00	100.00**	1.00**	3.25	8.50	5.50	6.00	8.25*
Tifton 44	12.50**	90.00*	100.00**	1.00**	2.75	9.00	6.75	7.25*	8.75*
Greenfield	2.00	91.25**	100.00**	1.00**	2.00	4.00	7.75*	8.25**	8.75*
Experimental Varieties - Not Available for Farm Use									
ERS 94X 2-8	0.25	20.00	80.00	0.25	4.25*	11.00**	4.75	1.50	3.50
LCB 84X 19-16	8.75*	65.00	97.50*	1.00**	4.50**	10.50*	5.50	6.25	7.00
ERS 94X 13-9	0.50	47.50	100.00**	0.50	3.00	8.00	5.00	4.50	6.75
SCRS-C	1.00	87.50*	100.00**	1.00**	2.25	5.50	7.00*	6.75	9.00**
LCB 84X 16-66	1.00	45.00	95.00*	1.00**	3.50	7.50	5.00	3.50	6.00
ERS 94X 6-13	0.25	20.00	65.00	0.25	2.00	4.00	5.25	1.75	3.50
A12199	2.00	90.00*	100.00**	1.00**	1.75	3.50	8.25**	8.00*	9.00**
ERS 94X 5-12	0.75	52.50	95.00*	0.75*	2.25	7.50	5.25	4.50	6.75
ERS-C	1.00	90.00*	100.00**	1.00**	1.75	4.25	7.50*	8.00*	9.00**
Avg.	2.58	64.48	94.38	0.81	2.77	6.94	6.13	5.52	7.19
CV (%)	116.0	13.3	6.9	36.2	21.0	15.2	15.8	15.2	13.1
5% LSD	4.31	12.33	9.38	0.42	0.84	1.51	1.40	1.21	1.35

**Highest numerical value in column
*Not significantly different from the highest numerical value in the column based on 5% LSD
[1]Visually estimated percent of plot area with new growth
[2]Height of new plant growth in plots with growing plants
[3]Rated from 0 to 9, with 9 being most dense.

Table 9. Forage yields (tons dry matter/acre) of commercial and experimental bermudagrass varieties in Test 1998-2, South Central Research Station, Chickasha, OK. 1999-2002.

	2002 Harvests					4-Yr
	6/3	7/16	8/26	11/15	Total	Avg.
Commercial Varieties – Available for Farm Use						
Midland 99	3.10*	2.64**	2.29*	1.12	9.14**	10.62**
Tifton 44	3.33*	1.95	2.29*	0.88	8.45*	10.10*
Greenfield	2.46*	0.89	1.50	0.68	5.52	6.30
Experimental Varieties – Not Available for Farm Use						
ERS 94X 2-8	1.69	2.01	1.76	1.35	6.80	10.00*
LCB 84X 19-16	3.04*	1.82	2.20*	0.86	7.92*	9.54
ERS 94X 13-9	2.66*	1.51	2.72**	1.14	8.02*	9.46
SCRS-C	3.54**	0.83	1.94	0.95	7.26	9.17
LCB 84X 16-66	2.38	1.39	1.62	1.44	6.82	8.34
ERS 94X 6-13	0.91	1.28	2.09	0.72	4.99	7.63
A12199	2.23	1.29	1.72	0.91	6.15	6.98
ERS 94X 5-12	1.65	1.25	2.08	1.05	6.02	6.89
ERS-C	2.05	0.84	0.92	0.51	4.32	5.36
Avg.	2.42	1.47	1.93	0.97	6.78	8.37
CV (%)	31.2	23.15	21.9	43.9	18.3	15.7
5% LSD	1.08	0.49	0.61	NS	1.79	0.92

**Highest numerical value in column
*Not significantly different from the highest numerical value in the column based on 5% LSD

Table 10. Visual ratings or measurements of early season growth of bermudagrass varieties in Test 2000-1, Eastern Research Station, Haskell, OK. 2002.

Variety	April 12, 2002	
	Green-up[1]	Height[2]
	---------- % ----------	---------- Inches --------
Seeded Varieties		
KF 194	5.25	0.50
CD90160	2.50	0.25
Cheyenne	5.00	0.88
Common	1.25	0.13
Guymon	50.00*	1.75**
Ranchero Frio	21.25	0.88
Tierra Verde	6.25	0.88
Wrangler	57.50**	1.75**
Clonal Standard Varieties		
Midland 99	11.25	0.75
Ozark	40.00	0.75
Tifton 44	25.00	0.63
Avg.	20.48	0.83
CV (%)	46.7	59.1
5% LSD	13.82	0.71

**Highest numerical value in column
*Not significantly different from the highest numerical value in the column based on 5% LSD
[1]Visually estimated percent of total plot area with new growth
[2]Height of new plant growth in plots with living plants

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Table 11. Forage yields (tons dry matter/acre) of seeded bermudagrass varieties in Test 2000-1, Eastern Research Station, Haskell, OK. 2000-2002.

Variety	2002 Harvests					3-Yr
	5/22	6/26	8/8	10/31	Total	Avg.
Seeded Varieties						
KF-194	0.00	2.38	2.94	1.60*	6.92	6.49
Guymon	1.24	3.06	2.88	0.73	7.90	6.35
Tierra Verde	0.00	2.56	3.51**	1.69*	7.76	6.31
Rancho Frio	0.00	2.40	3.29*	1.75*	7.44	6.30
Wrangler	1.58	2.95	2.84	0.66	8.03	6.15
Common	0.00	1.62	3.20*	1.79**	6.61	6.13
Cheyenne	0.00	2.22	3.02	1.70*	6.94	6.12
CD 90160	0.00	1.57	3.32*	1.78*	6.67	5.93
Clonal Standard Varieties						
Midland 99	1.23	3.66**	3.22*	1.46*	9.56**	7.77**
Tifton 44	1.05	3.22*	3.02	1.59*	8.88*	6.98
Ozark	1.27	3.37*	2.99	1.95*	9.58*	7.31
Avg.	1.27	2.64	3.11	1.52	7.84	6.53
CV (%)	20.7	15.4	7.6	17.3	6.8	7.7
5% LSD	NS	0.59	0.34	0.38	0.77	0.41

**Highest numerical value in column
*Not significantly different from the highest numerical value in the column based on 5% LSD

Table 12. Visual ratings or measurements of early season growth of bermudagrass in Test 2001-1, Eastern Research Station, Haskell, OK. 2002.

Variety	4/12/02	5/21/02		
	Height[1]	Height	Green-up[2]	Density[3]
	---------- Inches ----------		------- % --------	---- Rating ----
Commercial Varieties - Available for Farm Use				
Midland 99	1.75*	23.50**	88.75	5.50
Ozark	1.75*	18.75	96.25*	7.00
Tifton 44	2.25*	21.00*	95.00*	7.25
Experimental Varieties – Not Available for Farm Use				
A-12244	1.75*	18.50	83.75	5.50
A-12245	2.00*	23.00*	100.00**	7.00
A-12246	2.00*	22.00*	98.75*	6.50
ERS 16S-1	2.00*	19.25	97.50*	7.25
ERS 16S-2	2.25*	20.00	80.00	5.50
ERS 16S-3	2.50**	19.75	96.25*	8.50*
ERS 16S-4	2.25*	18.50	83.75	5.75
ERS 16S-5	2.25*	11.75	98.75*	9.00**
ERS 16S-6	2.25*	17.75	78.75	6.25
ERS 16S-7	2.50**	18.50	83.75	6.50
ERS 16S-8	2.25*	16.50	88.75	6.25
ERS 16S-9	2.25*	16.75	81.25	6.50
ERS 16S-10	2.50**	21.00*	91.25	6.50
LCB 84X 16-66	1.75*	18.00	70.00	5.75
Avg.	2.13	19.09	88.97	6.62
CV (%)	34.9	9.3	5.4	11.2
5% LSD	1.06	2.53	6.81	1.06

**Highest numerical value in column
*Not significantly different from the highest numerical value in the column based on 5% LSD
[1]Height of new plant growth
[2]Visually estimated percent of total plot area with new growth
[3]Stand density ratings 1 to 9, with 9 representing highest density

Table 13. Forage yields (tons dry matter/acre) of commercial and experimental bermudagrass varieties in Test 2001-1, Eastern Research Station, Haskell, OK. 2002.

Variety	2002 Harvests 5/22	6/27	8/8	11/6	Total
Commercial Varieties - Available for Farm Use					
Ozark	2.42	3.29*	3.76*	2.25*	11.71**
Midland 99	2.32	3.46*	3.54*	2.18*	11.49*
Tifton 44	2.49	3.17	3.48*	1.77	10.90*
Experimental Varieties – Not Available for Farm Use					
A-12245	2.62	3.12	3.89**	1.81	11.44*
ERS 16S-10	3.15**	3.37*	3.70*	1.10	11.31*
ERS 16S-4	1.93	2.89	3.61*	2.55**	10.97*
ERS 16S-7	2.18	3.42*	3.62*	1.68	10.89*
ERS 16S-2	2.09	3.00	3.18	2.34*	10.61
ERS 16S-9	1.76	3.51*	3.47*	1.86	10.61
A-12246	2.28	3.66**	3.71*	0.86	10.51
ERS 16S-6	1.88	3.43*	3.37	1.52	10.20
ERS 16S-3	2.51	3.18	3.49*	0.70	9.89
ERS 16S-1	2.08	3.04	3.51*	1.10	9.73
LCB 16-66	1.83	2.78	3.22	1.78	9.61
ERS 16S-8	1.90	3.25	3.06	1.09	9.29
A-12244	1.86	3.03	3.04	1.10	9.03
ERS 16S-5	1.55	3.14	3.07	0.38	8.13
Avg.	2.17	3.22	3.45	1.53	10.37
CV (%)	14.3	8.07	8.49	21.0	6.9
5% LSD	0.44	0.37	0.42	0.46	1.02

**Highest numerical value in column
*Not significantly different from the highest numerical value in the column based on 5% LSD

Table 14. Forage yields (tons dry matter/acre) of commercial and experimental bermudagrass varieties in Test 2001-2, South Central Research Station, Chickasha, OK.

Variety	2002 Harvests 6/3	7/16	8/26	11/15	Total
Commercial Varieties - Available for Farm Use					
Tifton 44	3.66*	2.47*	2.78	2.81*	11.72*
Midland 99	3.20	2.70*	3.07*	2.01*	10.97*
Experimental Varieties – Not Available for Farm Use					
ERS 16S-4	3.04	2.79**	3.47**	3.15*	12.44**
A12246	3.48*	1.96*	3.35*	3.26**	12.04*
A 12245	3.47	2.42*	2.98*	2.95*	11.82*
ERS 16S-3	3.71*	2.28*	2.77	2.67*	11.44*
ERS 16S-1	3.22	2.12*	2.46	2.58*	10.37*
LCB 84X 16-66	3.75**	2.36*	2.47	1.52	10.08
ERS 16S-9	2.58	1.94*	2.92*	2.54*	9.98
ERS 16S-5	3.37*	2.04*	2.75	1.63	9.79
A12244	3.10	1.77	2.46	2.41*	9.73
Avg.	3.38	2.24	2.87	2.58	11.07
CV (%)	6.2	19.8	12.4	28.6	9.8

**Highest numerical value in column
*Not significantly different from the highest numerical value in the column based on 5% LSD
[1]Ozark and experimental varieties ERS 16S-2, 6, 7, 9 & 10 were not harvested due to herbicide injury.

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Additional information on forage bermudagrass and related topics is contained in these publications available from your Cooperative Extension Office:

PT 2002-3	Performance of Forage Bermudagrass Varieties in Oklahoma Tests, 1998-2001.
PT 2001-9	Performance of Forage Bermudagrass Varieties in Oklahoma Tests, 1998-2000.
PT 2000-8	Performance of Forage Bermudagrass Varieties in Oklahoma Tests, 1995-99.
PT 96-9	Performance Of Forage Bermudagrass Varieties In Oklahoma Tests, 1992-1995.
PT 1998-14	Performance Of Forage Bermudagrass Varieties In Oklahoma Tests, 1995-1997.
F-2117	Forage Quality Interpretations
F-2568	Protein-Nitrogen Relationships in Forages
F-2583	Bermudagrass Varieties for Oklahoma
F-2587	Bermudagrass for Grazing or Hay

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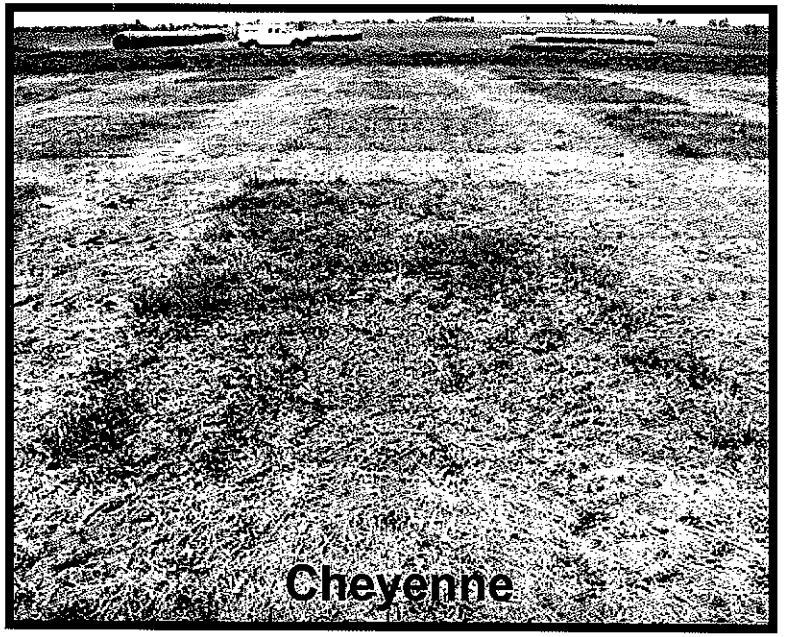
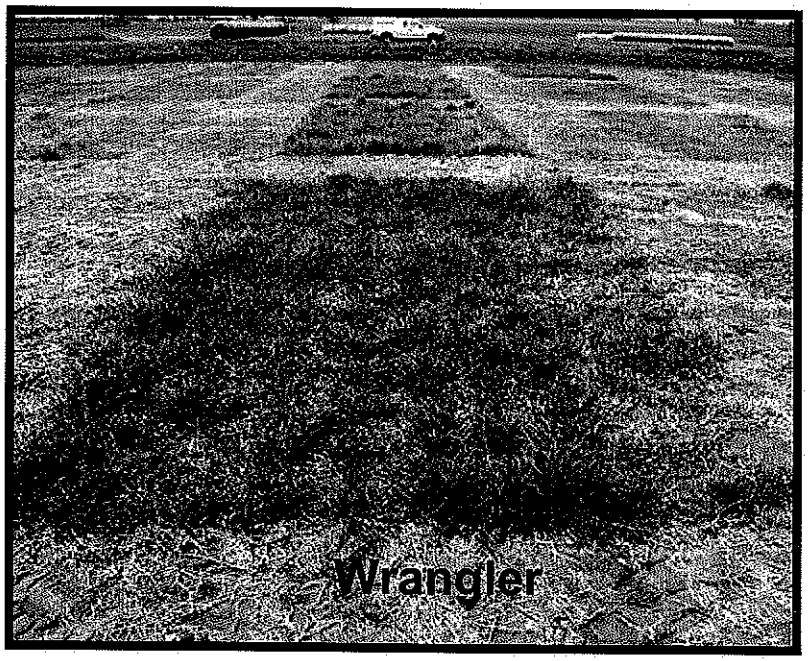
Item 16. Exhibit B-3

20060065





Relative greenup and growth of Arizona Common, Cheyenne, and Wrangler bermudagrasses April 25, 2001 in Test 2000-1, Eastern Research Station, Haskell, OK.

Seeded Bermudagrass Variety Trial 2001

Chris Teutsch and Mac Tilson
Southern Piedmont AREC
Blackstone, VA

Although past research has clearly demonstrated both the yield potential and adaptation, relatively little improved bermudagrass is grown in Virginia. The sprigging process has limited use since sprigs and sprigging equipment are not readily available. Recent releases of seeded forage bermudagrass varieties with improved cold tolerance may have the potential to facilitate the adoption of bermudagrass in Virginia. Seeded bermudagrass is established in the same manner as other small seeded forage crops. Therefore, the necessary equipment and knowledge required for successful establishment already exists on most farms in Virginia. However, no information on the adaptation, productivity, or management of seeded forage bermudagrasses is available for Virginia. This study was designed to determine the yield, nutritive value, and persistence of newly available seeded bermudagrass cultivars.

MATERIALS AND METHODS

In June 2001, eleven seeded bermudagrasses and a hybrid check were established at the Southern Piedmont AREC near Blackstone, VA (Table 1). Seeded bermudagrass is marketed as a pure variety or a blend of varieties, common, and giant bermudagrass. In some cases, these blends do not remain consistent from year to year. Therefore, when interpreting results from yield trials it is important that the blend components be considered rather than the tradename.

The experimental design was a randomized complete block with four replications. Plot size was 6 x 15 feet with a 3 feet border maintained between each plot. A conventional seedbed was prepared by plowing, disking, and cultipacking. Plots were seeded using a cultipacker type seeder at a rate of 8 lb PLS/A. Starter fertilizer consisted of 50 lb/A of nitrogen (N), phosphate (P_2O_5), and potash (K_2O) disked into the seedbed prior to establishment. An additional 50 lb/A of N, and 100 lb/A P_2O_5 and K_2O were applied in September 2001. Summer annual grasses were controlled during establishment using MSMA Plus at rate of 22 oz/A on 20 July 2001 and 7 Aug 2001. In 2002 plots received 100 lb/A of N, P_2O_5, and K_2O on 14 Apr 2002, and 100 lb N/A on 31 May 2002, 15 Jul 2002, and 20 Aug 2002. In 2003 plots received 100, 33, and 132 lb/A of N, P_2O_5, and K_2O, respectively on 15 Apr 2003, 4 Jun 2003, 22 Jul 2003, 19 Aug 2003, and 50, 16, and 66 lb/A of N, P_2O_5, and K_2O, respectively on 25 Sep 2003. One ton of lime was applied on 11 Mar 2003. Winter annual broadleaf weeds were controlled using 0.10 oz/A of Ally on 17 Apr 2002 and 24 Mar 2003.

Yield was determined by clipping and weighing a 4-ft wide strip through the center of each plot using a self-propelled sickle-bar type forage harvester. The clipping

height was 2.5 inches above the soil surface. Plots were harvested for yield on 30 Aug 2001, 10 Dec 2001, 31 May 2002, 10 Jul 2002, 15 Aug 2002, 31 Sep 2002, and 22 Oct 2002, 19 Jun 2003, 14 Jul 2003, 15 Aug 2003, 17 Sep 2003, and 24 Oct 2003. A subsample of fresh forage was collected from each plot for DM determination and forage quality analysis. The forage was then ground to pass through a 2 and 1 mm screen using Wiley (Thomas Scientific, Swedesboro, NJ) and Cyclone sample mills (Udy Corporation, Fort Collins, Co), respectively. Samples were analyzed for neutral detergent fiber (NDF), acid detergent fiber (ADF), and crude protein (CP) using near infrared spectroscopy (NIRS) (Martin et al., 1989; Shenk and Westerhaus, 1995). Spring green up was visually determined as percent green on a weekly basis starting 11 Apr 2003 and ending 21 May 2003. Data was analyzed using the general linear model procedure from SAS (SAS Institute, 1987). Means were separated using the least significant difference (Steel and Torrie, 1980).

RESULTS

Table 1. Establishment year yields for seeded bermudagrass varieties at the Southern Piedmont AREC, Blackstone, VA.

Variety	Company	Blend	08/29/01	12/10/01	Total 2001
			----------lb DM/A----------		
Pasto Rico	KF Seed	Common + Giant	4862	2165	7027
Rancho Frio	Seed West	Cheyenne + Wrangler	4615	2159	6774
Cheyenne	Seed West	no	4160	2388	6547
Mirage	Cebeco Seeds	no	4278	1510	5788
KF 194	KF Seed	no	3927	1565	5492
SunGrazer	KF Seed	KF194 + Wrangler	3907	1241	5149
Mohawk	Seed West	no	3917	985	4902
Pyramid	Cebeco Seeds	no	3736	1045	4782
Cd90160	Cebeco Seeds	no	3744	978	4723
Wrangler	Johnston Seed	no	3695	0	3695
Guymon	Johnston Seed	no	3664	0	3664
LSD (0.05)			**771**	**718**	**1004**

Table 2. Mean temperature and precipitation at Southern Piedmont AREC, Blackstone, VA.

Month-Year	Temperature (F)		Precipitation (in)	
	Mean	Deviation from Normal	Mean	Deviation from Normal
May-01	66.2	0.5	2.83	-0.91
Jun-01	75.3	2.0	8.55	4.68
Jul-01	74.8	-2.7	4.98	0.35
Aug-01	78.1	2.1	2.86	-1.20
Sep-01	67.8	-1.7	1.05	-2.70
Oct-01	59.7	1.0	0.26	-3.09
Nov-01	56.4	7.3	0.29	-2.80
Dec-01	47.3	7.1	1.88	-1.31
Jan-02	44.0	6.4	3.56	0.12
Feb-02	44.4	4.2	1.13	-2.21
Mar-02	50.5	3.1	4.70	0.84
Apr-02	61.5	4.1	1.61	-1.72
May-02	65.8	0.1	3.00	-0.74
Jun-02	76.4	3.1	1.68	-2.19
Jul-02	80.2	2.7	2.82	-1.81
Aug-02	77.8	1.8	3.98	-0.08
Sep-02	71.2	1.7	2.08	-1.67
Oct-02	59.9	1.2	6.89	3.54
Nov-02	48.1	-1.0	4.18	1.09
Dec-02	40.3	0.1	4.28	1.09
Jan-03	35.1	-2.5	1.08	-2.36
Feb-03	37.6	-2.6	6.14	2.80
Mar-03	49.3	1.9	5.60	1.74
Apr-03	55.6	-1.8	6.07	2.74
May-03	61.8	-3.9	13.73	9.99
Jun-03	69.6	-3.7	6.31	2.44
Jul-03	73.8	-3.7	6.53	1.90
Aug-03	74.3	-1.7	2.54	-1.52
Sep-03	70.5	1.0	10.95	7.20

Table 3. 2002 yields for seeded bermudagrass varieties at the Southern Piedmont AREC, Blackstone, VA.

Variety	05/31/02	07/10/02	08/15/02	09/13/02	10/22/02	Total-2002
	lb DM/A					
Pasto Rico	6213	4404	3771	2958	2227	19572
Cheyenne	5827	3795	3974	3266	2283	19144
Ranchero Frio	5417	4307	3828	2830	2399	18781
KF-194	4449	2647	3726	2565	2074	15461
Cd90160	3277	3420	3729	2498	2394	15318
SunGrazer	4408	2061	3640	2455	2427	14991
Pyramid	4051	2496	3544	2403	2303	14796
Mohawk	3626	2757	3756	2569	2045	14752
Mirage	3163	3261	3696	2419	2117	14655
Wrangler	4203	2112	3411	1996	1922	13643
Guymon	3042	1719	3662	2255	2171	12849
Tifton 44	0	1650	3420	2416	1788	9274
LSD (P=0.05)	**1880**	**740**	**ns**	**320**	**361**	**2098**

Table 4. 2002 first harvest nutritive value for seeded bermudagrass varieties at the Southern Piedmont AREC, Blackstone, VA.

Variety	CP	NDF	ADF	TDN	CP Yield	TDN Yield
	%				lb/A	
Pasto Rico	11	69	38	51	687	3177
Cheyenne	12	67	37	53	714	3058
Ranchero Frio	13	65	35	54	691	2887
KF-194	14	61	32	58	614	2576
Cd90160	16	61	30	60	522	1951
SunGrazer	16	60	30	60	704	2616
Pyramid	16	60	29	60	625	2419
Mohawk	17	61	30	59	568	2124
Mirage	14	61	31	59	450	1852
Wrangler	14	63	31	58	568	2443
Guymon	15	62	30	60	429	1788
Tifton 44	-	-	-	-	-	-
LSD (0.05)	**2.4**	**2.9**	**2.7**	**2.6**	**ns**	**ns**

Table 5. 2002 second harvest nutritive value for seeded bermudagrass varieties at the Southern Piedmont AREC, Blackstone, VA.

Variety	CP	NDF	ADF	TDN	CP Yield	TDN Yield
	----------%----------				----------lb/A----------	
Pasto Rico	10	66	34	56	498	2465
Cheyenne	12	64	31	59	448	2213
Ranchero Frio	12	64	32	59	498	2518
KF-194	15	57	25	65	392	1719
Cd90160	14	59	27	64	464	2176
SunGrazer	16	55	23	67	332	1389
Pyramid	15	57	25	66	357	1633
Mohawk	15	57	25	65	407	1792
Mirage	14	59	27	64	454	2078
Wrangler	16	61	27	63	329	1394
Guymon	16	59	26	64	275	1101
Tifton 44	16	64	30	59	260	979
LSD (0.05)	**1.4**	**2.1**	**2.3**	**2.3**	**79**	**414**

Table 6. 2002 third harvest nutritive value for seeded bermudagrass varieties at the Southern Piedmont AREC, Blackstone, VA.

Variety	CP	NDF	ADF	TDN	CP Yield	TDN Yield
	----------%----------				----------lb/A----------	
Pasto Rico	12	61	31	59	469	2223
Cheyenne	12	60	31	59	475	2341
Ranchero Frio	13	58	30	60	479	2316
KF-194	14	55	25	65	538	2434
Cd90160	15	54	24	66	548	2470
SunGrazer	16	53	24	67	567	2426
Pyramid	16	54	23	67	551	2388
Mohawk	15	55	25	66	564	2483
Mirage	14	54	25	66	530	2437
Wrangler	16	57	27	63	548	2149
Guymon	16	56	26	65	571	2360
Tifton 44	16	62	31	58	543	1989
LSD (0.05)	**1.0**	**1.5**	**1.2**	**1.3**	**54**	**269**

Table 7. 2002 fourth harvest nutritive value for seeded bermudagrass varieties at the Southern Piedmont AREC, Blackstone, VA.

Variety	CP	NDF	ADF	TDN	CP Yield	TDN Yield
	----------%----------				----------lb/A----------	
Pasto Rico	19	58	28	59	575	1804
Cheyenne	19	58	28	59	616	1992
Ranchero Frio	19	58	28	60	549	1729
KF-194	22	55	24	65	576	1672
Cd90160	22	57	25	66	540	1604
SunGrazer	22	55	24	67	549	1595
Pyramid	23	54	22	67	545	1599
Mohawk	23	55	23	66	581	1682
Mirage	21	56	25	66	515	1554
Wrangler	22	55	23	63	445	1312
Guymon	22	54	23	65	497	1482
Tifton 44	19	58	28	58	453	1469
LSD (0.05)	**0.9**	**1.5**	**1.0**	**1.1**	**57**	**199**

Table 8. 2002 fifth harvest nutritive value for seeded bermudagrass varieties at the Southern Piedmont AREC, Blackstone, VA.

Variety	CP	NDF	ADF	TDN	CP Yield	TDN Yield
	----------%----------				----------lb/A----------	
Pasto Rico	17	59	31	58	374	1294
Cheyenne	17	58	30	59	398	1350
Ranchero Frio	17	58	30	60	405	1431
KF-194	18	56	28	62	375	1275
Cd90160	17	59	29	61	413	1450
SunGrazer	18	56	27	62	428	1511
Pyramid	17	57	28	62	395	1422
Mohawk	18	57	27	62	377	1265
Mirage	17	58	28	61	360	1294
Wrangler	18	56	26	64	348	1223
Guymon	18	56	26	63	391	1367
Tifton 44	16	58	30	59	291	1060
LSD (0.05)	**1.0**	**1.8**	**1.3**	**1.4**	**60**	**221**

Table 9. 2002 spring greenup data for seeded bermudagrass varieties at the Southern Piedmont AREC, Blackstone, VA.

Variety	Spring Greenup					
	04/11/03	04/18/03	04/28/03	05/06/03	05/13/03	05/21/03
	----------% Green----------					
Wrangler	49	76	99	99	100	100
Tifton 44	36	69	89	85	90	96
Guymon	16	31	83	94	98	99
Mohawk	14	33	79	91	99	98
KF 194	11	18	75	94	100	100
Mirage	11	19	65	91	96	98
SunGrazer	10	18	64	89	99	100
Pyramid	9	21	63	91	98	98
CD 90160	8	14	64	90	95	95
Cheyenne	1	3	12	29	50	64
Ranchero Frio	1	3	6	25	51	68
Pasto Rico	0	1	3	13	30	44
LSD (0.05)	**11**	**15**	**18**	**15**	**15**	**13**

Table 10. 2003 yields for seeded bermudagrass varieties at the Southern Piedmont AREC, Blackstone, VA.

Variety	06/19/03	07/14/03	08/15/03	09/17/03	10/24/03	Total 2003
	----------lb DM/A----------					
Wrangler	5298	6563	3818	1596	1527	18801
Mohawk	3650	5493	3595	2449	2553	17739
SunGrazer	3993	5336	3587	2395	2406	17716
KF 194	3989	4942	3486	2221	2612	17250
Mirage	3586	5494	3317	2191	2509	17097
Guymon	4332	5580	3386	1314	2246	16859
Pyramid	3833	5253	3237	1536	2451	16310
CD 90160	3634	4857	3184	2036	2584	16294
Tifton 44	3688	5063	3390	1846	1663	15650
Ranchero Frio	1534	4967	3567	2700	2521	15288
Cheyenne	1547	4553	3584	2503	2508	14695
Pasto Rico	696	4369	3453	2403	2454	13375
LSD (0.05)	**869**	**892**	**350**	**535**	**311**	**1812**

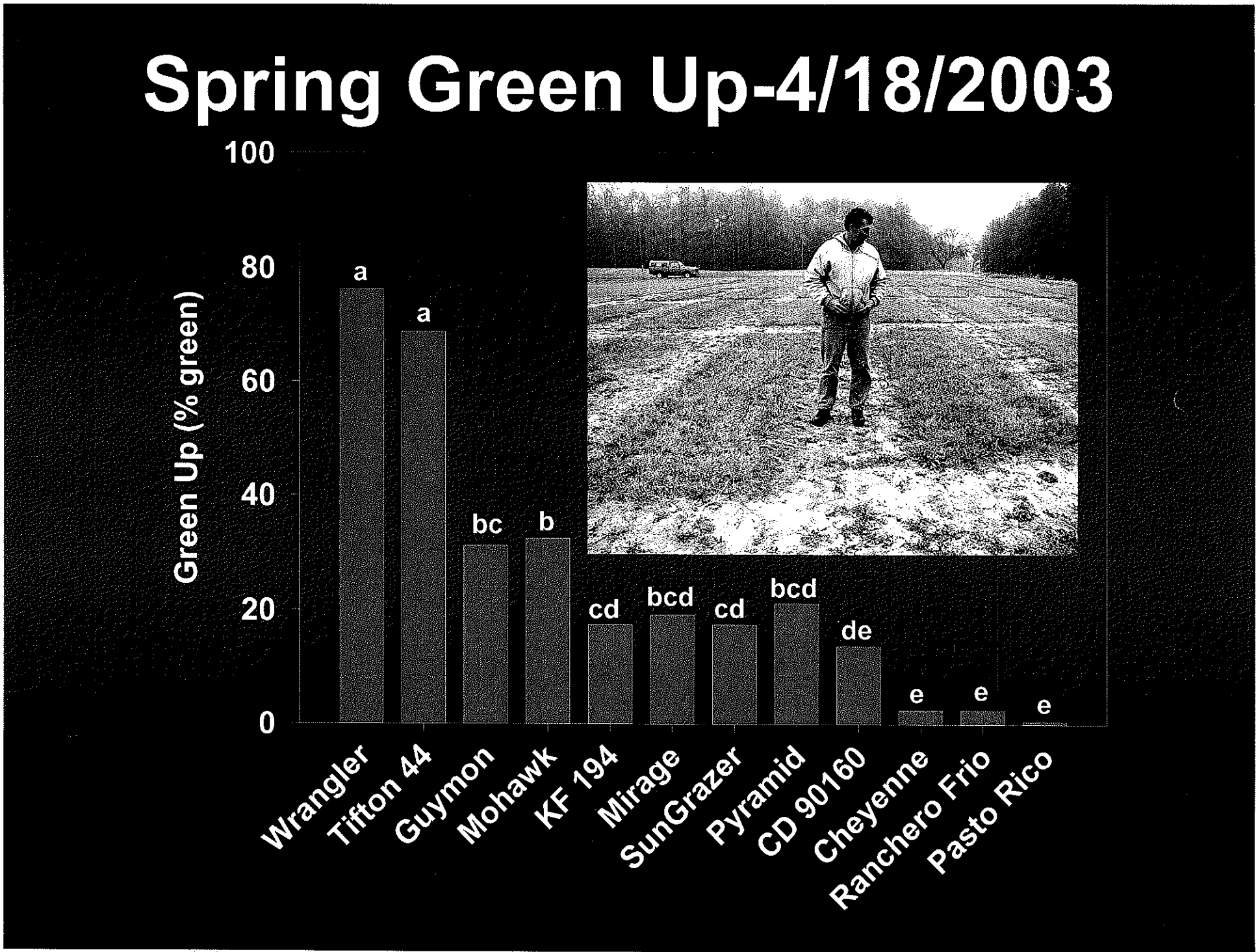
Seeded Bermuda Trial: Green Up Data for 2003 and 2004

Southern Pidmont AREC, Blackstone, VA

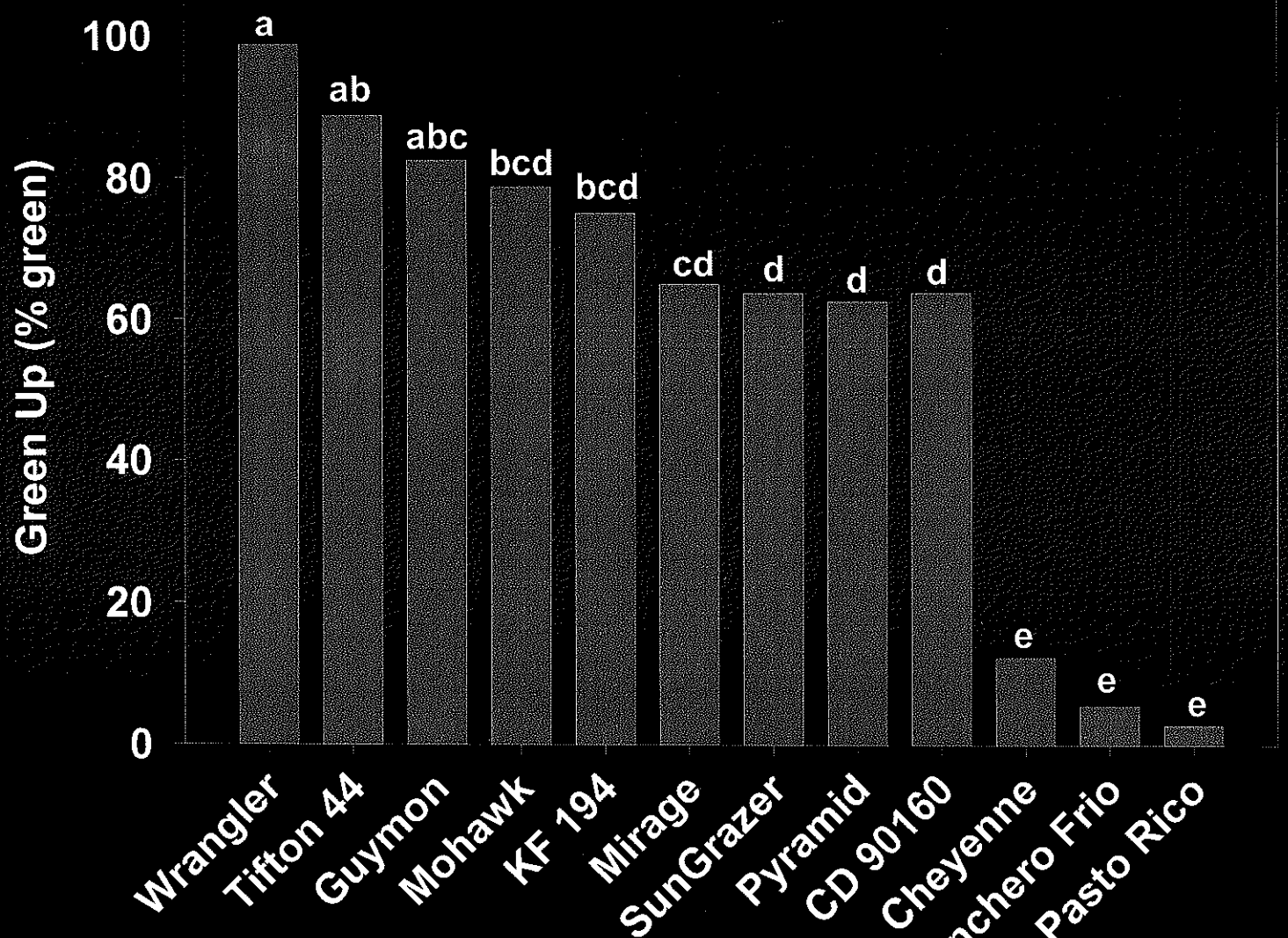
Variety	4/11/03	4/18/03	4/28/03	5/6/03	5/13/03	5/21/03	4/20/04	4/30/04	5/7/04	5/26/04
Pasto Rico	0.0	0.5	2.8	12.5	30.0	43.8	33.8	53.8	72.5	98.8
Ranchero Frio	0.5	2.3	5.5	25.0	51.3	67.5	23.8	42.5	73.8	97.5
Cheyenne	1.0	2.5	12.3	28.8	50.0	63.8	35.0	51.3	68.8	96.3
Cd90160	7.5	13.8	63.8	90.0	95.0	95.0	27.5	46.3	66.3	97.5
Pyramid	8.8	21.3	62.5	91.3	97.5	97.5	33.8	58.8	83.8	100.0
Sungrazer	10.0	17.5	63.8	88.8	98.8	100.0	56.3	60.0	81.3	100.0
Mirage	10.5	19.3	65.0	91.3	96.3	97.5	25.0	46.3	71.3	100.0
KF194	11.3	17.5	75.0	93.8	100.0	100.0	43.8	62.5	80.0	100.0
Mohawk	14.3	32.5	78.8	91.3	98.8	97.5	31.3	56.3	71.3	100.0
Guymon	16.3	31.3	82.5	93.8	97.5	98.8	72.5	81.3	90.0	100.0
Tifton 44	36.3	68.8	88.8	85.0	90.0	96.3	86.3	86.3	85.0	100.0
Wrangler	48.8	76.3	98.8	98.8	100.0	100.0	80.0	81.3	87.5	100.0
LSD (0.05)	**10.8**	**14.9**	**18.1**	**15.1**	**14.8**	**13.0**	**21.2**	**19.5**	**12.1**	**3.3**

Spring Green Up-4/11/2003

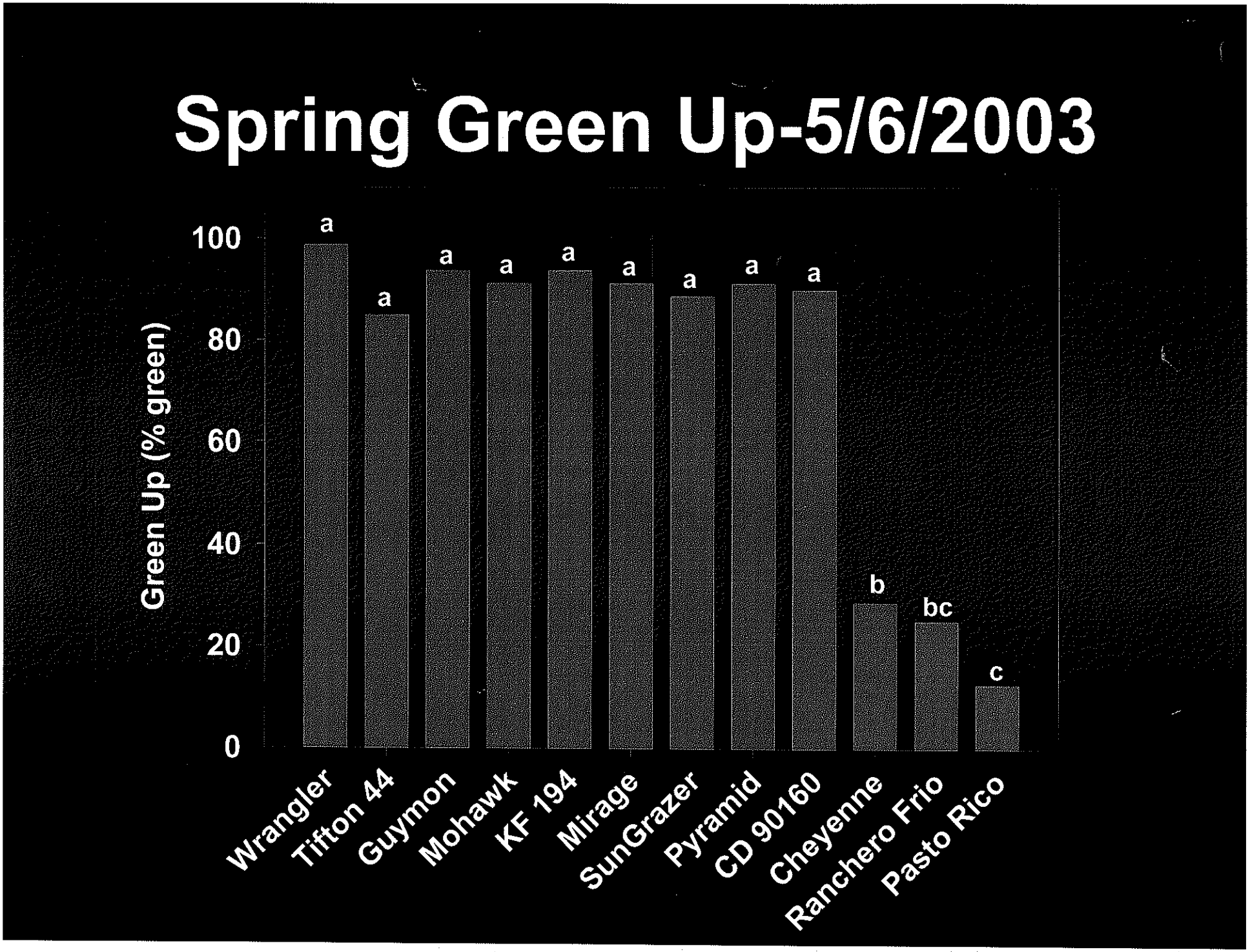
Spring Green Up-4/18/2003



Spring Green Up-4/28/2003

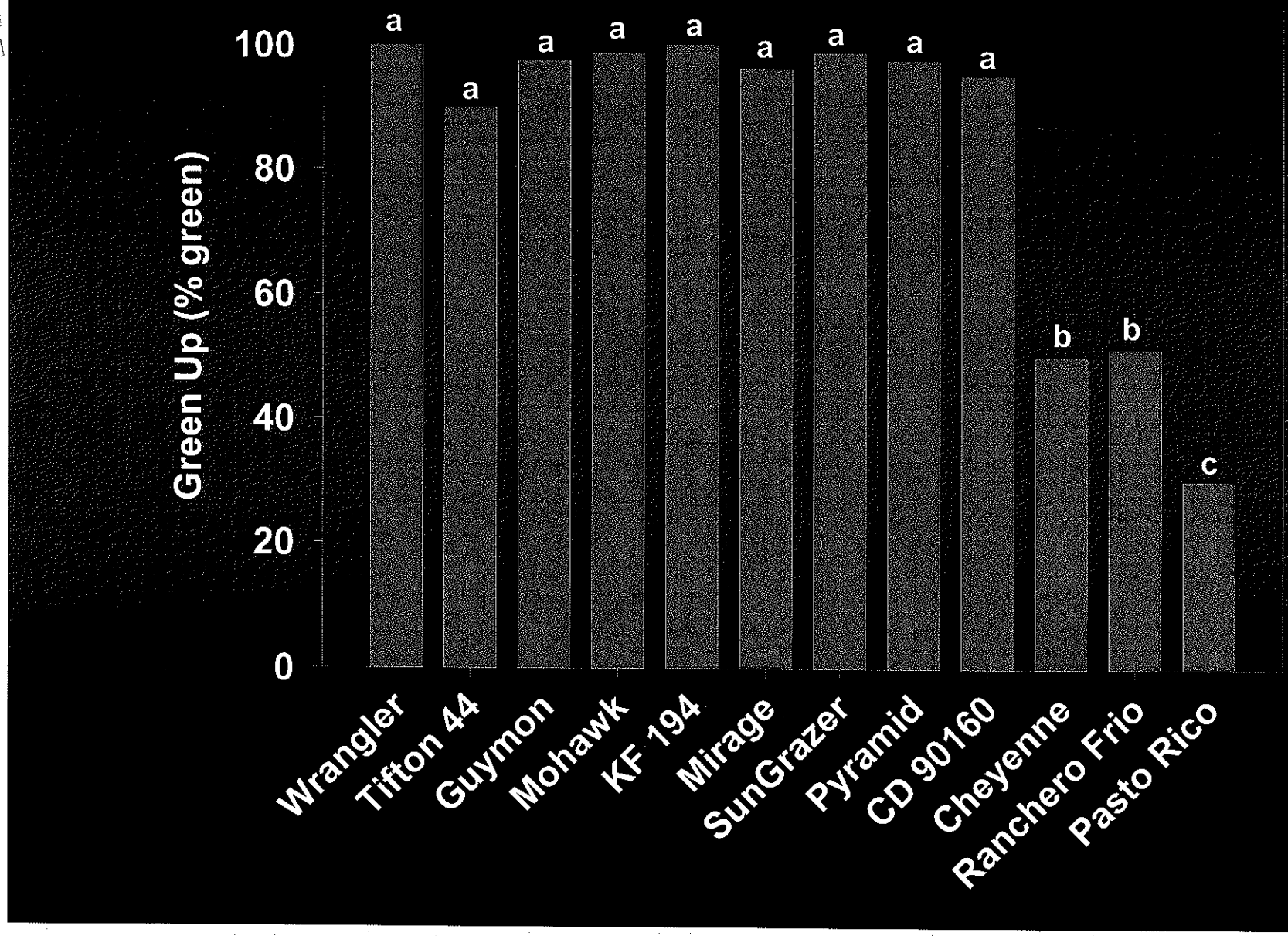



Spring Green Up-4/28/2003
'Guymon' 'Wrangler'
'Pasto Rico'
'Wrangler'
'Ranchero Frio'

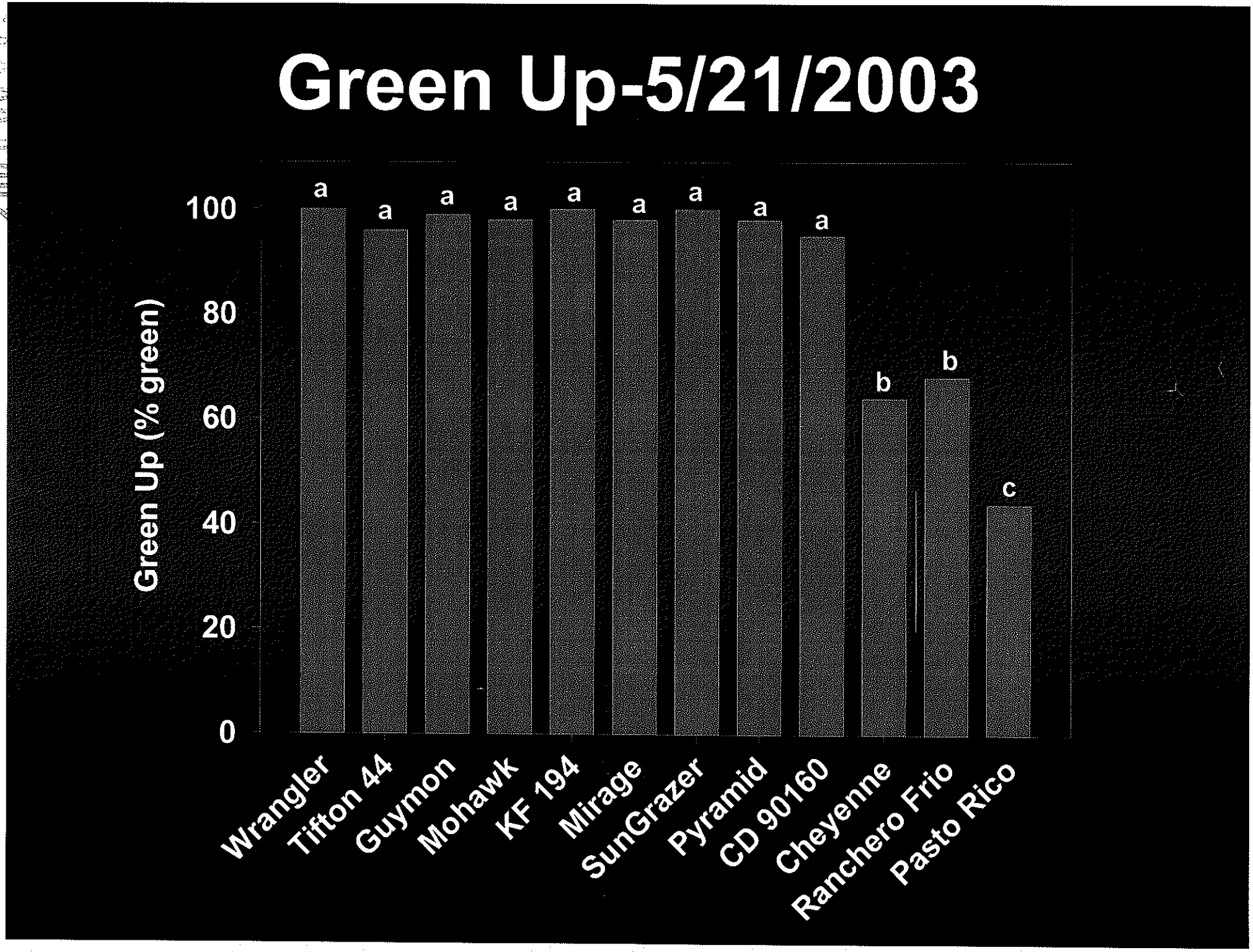

Spring Green Up-5/6/2003
Green Up (% green)
100
80
60
40
20
0
a
a
a
a
a
a
a
a
a
b
bc
c
Wrangler
Tifton 44
Guymon
Mohawk
KF 194
Mirage
SunGrazer
Pyramid
CD 90160
Cheyenne
Ranchero Frio
Pasto Rico


'Cheyenne'
'SunGrazer'
Spring Green Up-5/9/2003
'Pasto Rico'
'Wrangler'

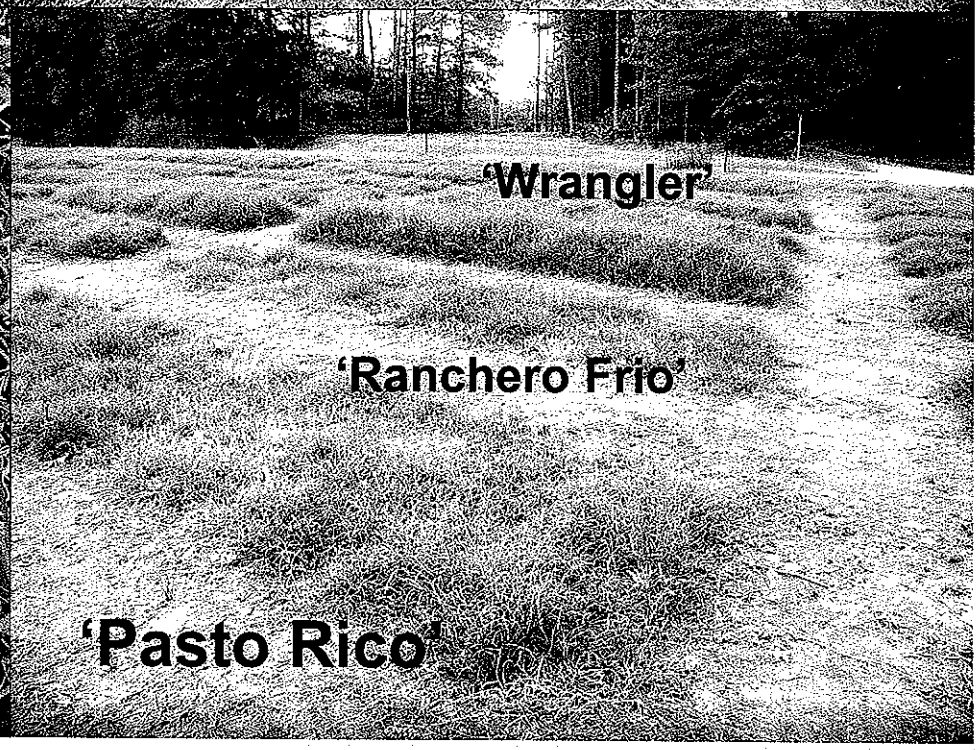
Spring Green Up-5/13/2003



Green Up-5/21/2003



Green Up-5/21/2003



Selecting a Variety

- Yield is important
- Cold tolerance is more important
- Do not use varieties that include 'Giant' and/or 'Arizona Common'
- Disease resistance??????

Extreme cold will kill all varieties!!!

2003 DM Yield: 2nd Production Yr

Variety	06/19	07/14	08/15	09/17	10/24	Total
	----------lb DM/A----------					
Wrangler	5298	6563	3818	1596	1527	18801
Mohawk	3650	5493	3595	2449	2553	17739
SunGrazer	3993	5336	3587	2395	2406	17716
KF 194	3989	4942	3486	2221	2612	17250
Mirage	3586	5494	3317	2191	2509	17097
Guymon	4332	5580	3386	1314	2246	16859
Pyramid	3833	5253	3237	1536	2451	16310
CD 90160	3634	4857	3184	2036	2584	16294
Tifton 44	3688	5063	3390	1846	1663	15650
Ranchero Frio	1534	4967	3567	2700	2521	15288
Cheyenne	1547	4553	3584	2503	2508	14695
Pasto Rico	696	4369	3453	2403	2454	13375

Performance of Seeded Bermudagrass Cultivars in the Northern Transition Zone

C.D. Teutsch, W.M. Tilson, and E.B. Aleshire
Virginia Tech

INTRODUCTION

- Past research demonstrated that bermudagrass is well adapted to Virginia
- Vegetative establishment has limited use
- Seeded bermudagrasses could facilitate adoption

OBJECTIVE

To evaluate the yield, nutritive value, and persistence of newly released seeded bermudagrass cultivars

MATERIALS AND METHODS

- Study conducted near Blackstone, VA
- Eleven seeded and one hybrid bermudagrasses were established in late June, 2001
- Plots received 100 lb N/A at spring green up and after each harvest except for the last
- Plots were harvested monthly and subsampled for dry matter and forage quality

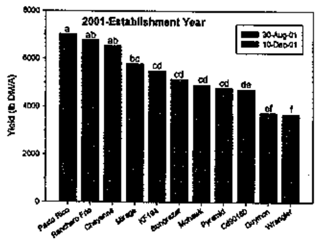


Figure 1. Establishment year yields.

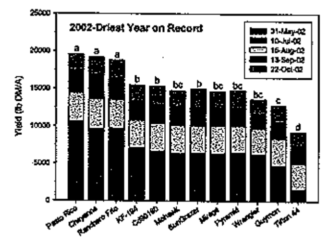


Figure 2. First production year yields.

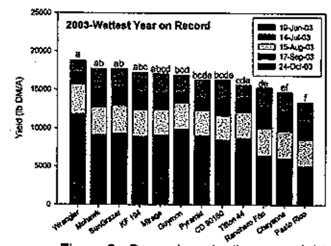


Figure 3. Second production year yields.

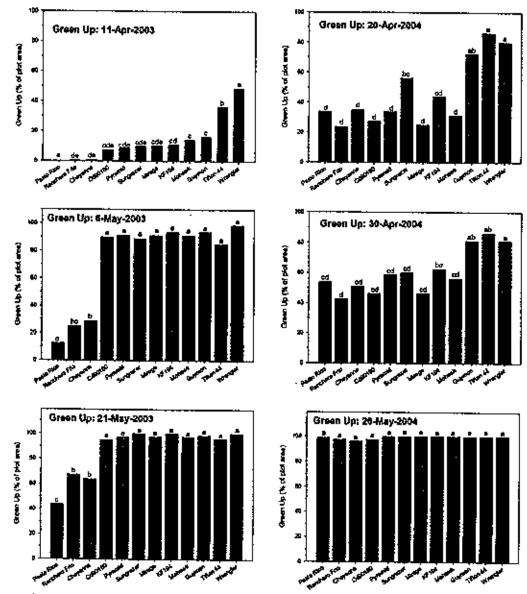


Figure 4. Spring green up data for 2003 and 2004.

Table 1. Crude Protein, ADF, NDF, and TDN for 2002.

Variety	31-May-2002				10-Jul-2002				15-Aug-2002				13-Sep-2002				22-Oct-2002			
	CP	ADF	NDF	TDN	CP	ADF	NDF	TDN	CP	ADF	NDF	TDN	CP	ADF	NDF	TDN	CP	ADF	NDF	TDN
	%																			
Cheyenne	12.3	36.6	67.0	52.6	12.3	31.1	63.5	59.2	12.0	31.4	60.3	59.0	18.9	27.0	57.9	61.1	17.4	29.9	58.3	59.1
Gaucho	16.2	29.6	60.9	59.8	13.8	27.0	58.9	63.8	14.7	24.6	54.3	66.4	21.0	24.0	56.9	64.2	17.3	26.7	58.5	60.8
Guymon	15.1	30.2	61.5	59.5	16.1	25.8	56.6	64.5	15.7	25.8	56.1	64.5	22.1	23.2	54.4	65.7	18.0	26.5	56.2	63.0
KF194	14.0	31.5	61.4	58.2	15.2	25.1	57.3	65.5	14.4	25.4	54.9	65.4	22.5	23.6	[illegible]	66.2	18.1	27.6	56.4	61.8
Mirage	14.4	31.0	61.4	58.7	14.0	26.6	59.0	63.9	14.4	24.9	54.4	66.0	21.3	24.8	56.2	64.3	17.0	26.3	57.6	61.1
Mohawk	16.7	29.8	60.8	59.4	15.0	25.3	57.4	65.4	15.1	24.6	54.6	66.1	22.7	23.2	[illegible]	65.5	18.4	27.4	57.1	61.8
Pasto Rico	11.2	38.2	68.8	51.2	10.2	34.3	66.5	56.1	12.4	31.3	60.6	59.0	19.8	27.8	[illegible]	[illegible]	16.8	30.8	59.4	58.2
Pyramid	16.2	29.3	60.2	60.2	14.7	24.5	57.0	66.5	15.6	23.4	53.6	67.4	22.7	22.3	[illegible]	66.0	17.2	27.7	57.3	61.6
Rancheo Frio	13.4	35.3	66.2	53.9	11.7	31.6	63.9	58.6	12.5	30.0	58.3	60.6	19.4	27.7	57.7	61.1	16.9	28.7	58.1	59.5
SunGrazer	16.3	29.6	60.0	59.8	16.1	23.3	54.8	67.4	16.8	24.0	53.4	66.7	22.4	24.7	[illegible]	65.0	17.7	27.1	56.1	62.3
Tifton 44	-	-	-	-	15.8	30.1	64.4	59.4	16.9	31.1	61.7	56.2	18.7	26.2	57.6	60.9	18.3	30.0	58.2	59.3
Wrangler	13.9	31.4	62.7	58.4	15.6	27.2	60.6	62.9	16.1	26.9	57.3	63.1	22.3	23.0	54.2	65.6	18.1	25.9	56.6	63.8
LSD (0.05)	2.4	2.7	2.9	2.0	1.4	2.3	2.1	3.3	0.8	1.2	1.5	1.3	0.9	1.6	1.5	3.1	1.0	1.3	1.6	1.4

Table 2. Crude Protein, ADF, NDF, and TDN for 2003.

Variety	19-May-2003				14-Jul-2003				15-Aug-2003				17-Sep-2003				24-Oct-2003			
	CP	ADF	NDF	TDN	CP	ADF	NDF	TDN	CP	ADF	NDF	TDN	CP	ADF	NDF	TDN	CP	ADF	NDF	TDN
	%																			
Cheyenne	13.8	29.1	55.3	61.2	10.1	35.9	64.2	64.2	14.7	34.6	65.0	54.5	19.3	28.1	61.0	59.5	18.9	27.8	58.7	60.8
Gaucho	14.9	30.0	57.9	60.7	11.0	35.4	64.0	64.5	18.3	32.6	63.4	58.0	19.4	28.3	61.4	60.4	18.3	28.4	59.0	60.4
Guymon	14.8	30.7	59.9	60.1	11.9	36.5	67.7	62.0	17.0	32.4	63.0	58.2	21.8	25.3	58.8	63.2	18.8	26.7	57.8	62.4
KF194	14.3	30.6	57.9	59.3	10.1	35.7	64.7	64.8	16.6	31.6	61.1	57.1	20.0	27.2	58.5	61.4	19.4	28.4	58.9	60.3
Mirage	14.3	29.7	56.6	60.3	10.7	35.1	63.2	55.0	16.0	32.2	61.6	56.8	19.4	28.1	59.5	60.6	19.4	28.7	59.4	59.9
Mohawk	14.7	30.9	59.2	58.7	10.8	35.7	63.8	64.2	16.3	31.6	61.3	57.4	19.7	27.8	59.5	60.6	18.6	28.3	59.3	60.3
Pasto Rico	13.6	28.0	53.7	62.4	10.6	36.0	64.5	53.9	15.1	34.3	63.7	54.6	19.6	28.5	59.8	60.1	19.4	27.9	58.9	60.8
Pyramid	15.5	29.8	57.8	59.8	10.7	34.0	61.4	58.3	17.0	31.1	61.5	57.6	20.0	27.3	58.7	61.4	19.7	27.8	58.8	60.4
Ranchero Frio	13.7	29.0	55.1	61.3	9.8	35.9	63.9	54.3	16.2	34.3	64.1	54.5	18.0	30.0	61.4	58.8	18.9	29.0	60.0	59.8
SunGrazer	14.5	30.1	57.0	59.6	11.2	34.5	62.9	55.6	16.1	32.4	61.5	56.5	19.8	28.0	59.1	60.5	20.2	27.9	58.8	60.8
Tifton 44	14.8	32.5	62.6	58.8	11.2	40.9	73.3	47.9	15.9	37.1	69.1	51.1	20.5	28.5	60.2	59.9	18.6	29.6	61.7	58.9
Wrangler	14.9	32.5	62.7	56.6	11.7	38.2	69.5	60.9	15.5	35.8	66.7	62.0	21.2	26.0	57.4	62.4	18.8	26.8	57.7	62.4
LSD (0.05)	[illegible]	1.2	1.8	1.4	1.8	1.4	2.1	1.1	0.9	0.8	1.3	0.9	1.0	1.2	1.4	1.2	[illegible]	1.2	1.8	1.3

SUMMARY

- Seeded cultivars yielded well in in establishment year
- No winter damage in spring 2002 due to a mild winter
- Seeded cultivars yielded well in 2002 (dry) and 2003 (wet)
- Colder than normal winter in 2002-03 resulted in winter kill in Cheyenne, Pasto Rico, and Ranchero Frio
- Wrangler, Guymon, and Tifton 44 greened up earliest and showed the best cold tolerance
- Cold tolerance should be given as much or more consideration than yield when selecting a cultivar in the transition zone
- Well-managed bermudagrass would likely meet nutritional requirements of brood cows

Figure 5. Extension agents J.B. Daniel and Mark Davis inspect cold injury in a seeded bermudagrass plot in early May, 2003.

Contact: Chris Teutsch, cteutsch@vt.edu

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U.S. DEPARTMENT OF AGRICULTURE
AGRICULTURAL MARKETING SERVICE
BELTSVILLE, MARYLAND 20705

Exhibit 14C

OBJECTIVE DESCRIPTION OF CULTIVARS
BERMUDAGRASS
(Cynodon spp.)

NAME OF APPLICANT(S)	VARIETY NAME OR TEMPORARY DESIGNATION
Johnston Seed Company	Wrangler
ADDRESS (Street and no., or R.F.D. No., City State and ZIP Code	FOR OFFICIAL USE ONLY
319 West Chestnut Enid, Oklahoma 73702	PVPO NUMBER 200000065

Place the appropriate number that characterizes the variety in the boxes below. Place a zero in the first box as necessary to fill all blanks (e.g. 0/9/9or 0/9/) when number is either 99 or less or 9 or less. The symbol "▲" indicates decimal. Characteristics marked with an * asterisk are preferred to be recorded. Characteristics described, including numerical measurements, should represent those which are TYPICAL for the variety. Ranges may be given also. Comparisons to standard varieties must be made under the same conditions. Append all pertinent comparative trial and evaluation data.
Measured data should be for unclipped spaced plants that represent application and standard cultivars, or replicated unclipped plots or individual unclipped pots if grown in greenhouse. Data should be obtained from mature plants (specify age of plants when measured). A minimum of 60 plants should be used for all measurements of seeded cultivars. A minimum of 15 plants should be used for all measurements of vegetative cultivars. Give location of test area, specify growing conditions and experimental design:____

STANDARD CULTIVARS Use cultivars from same species and ploidy level

x 1 = Seeded Common	4 = Tifway	7 = Coastal
x 2 = Guymon	5 = Tifgreen	8 = Coastcross-1
3 = Mirage	6 = Midiron	9 = Giant

10 = other (Specify species)_____

1. SPECIES: (With comparison varieties for use below - use varieties within species of application variety).

* [1] 1 = *C. dactylon* var. *Dactylon*
2 = *C. dactylon* var. *Aridus*
3 = *C. transvaalensis*
4 = *C. dactylon* X *C. transvaalensis*
5 = Other (Specify)_____

2. CYTOLOGY

* [4][2] 2n Chromosome Number 1 = diploid 3 = triploid
[2] Ploidy 2 = tetraploid 4 = Other (Specify) _____

3. U. S. ADAPTATION: (0= Not tested; 1= Inadequately Tested; 2= Not Adapted; 3 = Adapted).

*	1	Northwest	1	North Central	1	Northeast		Other _____
	3	West	3	Central	3	East Central		Other _____
	3	Southwest	3	South Central	1	Southeast		Other _____

4. RHIZOMES

6

1 = None (Coastcross-1)
4 = Weakly rhizomatous (Coastal)
6 = Moderately rhizomatous (Common)
9 = Heavily rhizomatous

[ ][ ] cm amount of spread in 1 year

5. STOLONS AND SHOOTS:

Anthocyanin pigmentation (cool temperature) Examples: present in Common, absent in Midland.
Specify site, season and growing conditions:_____

[ ][ ][ ] % of plants with anthocyanin pigmentation

Stolon internode diameter measured from center of 3rd fully extended internode from apical meristem.

1▲9 1 mm internode diameter 01 - 1▲05mm
02 - 1▲56mm

* Stolon internode length at third fully extended internode from the meristem.

5 8▲3 mm internode length

[ ][ ][ ] mm less in length than [ ][ ] Standard

length same as [ ][ ] Variety

0 4▲3 mm more in length than 0 2

1 6 8 0 1

* 1▲1 Number of growing points at a mature node. Recommend 4th node.
4 Specify which node was counted.

12 7▲8 cm length of longest stolon. or [ ][ ][ ] mm stolon length measured from the stolon apical meristem to the 5th node of the central stolon.

12 4▲9 - 01
14 0▲2 - 02

6. LEAF BLADE:

* 5 Green Color

1 = Light Green (Seeded Common)
3 = Light Medium Green
5 = Medium Green (Guymon)
6= (Tifgreen)
7 = Medium Dark Green (Tifway)
9 = Very Dark Green

[ ] Other color 1 =Bluegreen
2 =specify_____

[ ][ ][ ] % plants with other color

54

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3	Width Class	1 = Very Coarse (Coastcross-1) 3 = Coarse (Midland, Guymon) 5 = Medium (Seeded Common) 7 = Medium Fine (Tifway) 9 = Fine (Tifgreen)

* Leaf width measurement on first fully extended leaf of upright growth. Measure width at widest part about 1 cm from base.

3 ▲ 3	mm width		
	mm narrower than		
	width same as	0 2	Standard Variety
0 ▲ 6	mm wider than	0 1	

* Leaf length measurement on first fully extended leaf of upright growth.

38 ▲ 4	mm length		
	mm shorter than		
	Blade length same as	0 2	Standard Variety
11 ▲ 5	mm longer than	0 1	

* Flag leaf width. Measure width at widest part about 1 cm from base.

4 ▲ 1	mm width		
	mm narrower than		
	Blade width same as		Standard Variety
1 ▲ 9	mm wider than	0 1	
0 ▲ 2		0 2	

Flag leaf length

46 ▲ 3	mm length		
04 ▲ 9	mm shorter than	0 2	
	Blade length same as		Standard Variety
22 ▲ 9	mm longer than	0 1	

* Leaf width (lateral leaves) Measure the widest part of the first fully extended leaf from tip of stolon.

4 ▲ 0	mm width		
	mm narrower than		
	Blade width same as		Standard Variety
0 ▲ 9	mm wider than	0 1	
0 ▲ 3		0 2	

* Leaf length (lateral leaves) Measure the first fully extended leaf from tip of stolon.

13 ▲40 mm ~~width~~ (length)

mm ~~narrower~~ shorter than

Blade ~~width~~ same as Standard Variety

39 ▲5 mm ~~wider~~ longer than 01

16 ▲8 02

Leaf hairs (use 1 = absent to 9 = abundant or very long)

number on leaf blade length

number on sheath length

number on collar length

7. INFLORESCENCE Specify site, season, and growing conditions:

* Inflorescence length. The length of the racemes on the inflorescence.

42 ▲ 4 mm length

mm shorter than

same as 01 & 02 Standard variety

mm longer than

Number of racemes per inflorescence.

5 ▲3 number

less than

same as 01 02 Standard variety

more than

Number of whorls per inflorescence

number

% of plants with more than one whorl of branches/inflorescence

% of inflorescences with more than 1 whorl

Spikelets per raceme

32 ▲ 4 number

5 ▲ 6 less than 01 & 5▲7 less than 02

same as Standard variety

more than

Raceme density [number of racemes/ $(0.2\ m)^2$]

% of plants with spike anthocyanin

58

Stigma color (within 24 hours after anthesis)

	% plants with white stigmas
	% plants with light purple stigmas
	% plants with purple stigmas

Anther color (within 24 hours after anthesis)

100	% plants with purple anthers	000	% plants other (specify)_____
	% plants with yellow anthers		% plants other (specify)_____

* Head exsertion. Measure from the base of the inflorescence to the flag leaf.

86▲6	mm length	
	mm shorter than	Standard
	same as	variety
61▲5	mm longer than	01

4 3▲8 0 2

Peduncle length

	mm length internode from base of whorl to first node	
	mm shorter than	
	same as	Standard variety
	mm longer than	

* First internode length

68▲8	mm length	
	mm shorter than	
	same as	Standard variety
17▲4	mm longer than	01

10▲6 0 2

Flag leaf sheath length (measured from node to flagleaf base)

	mm length	
	mm shorter than	
	same as	Standard variety
	mm longer than	

200000065

8. PLANT HEIGHT
(specify site, time, growing conditions). _____

* Plant height. Measure at maturity, using the tallest inflorescence per plant and hold out to furthest extension for measurement.

45▲0	cm height	
	cm shorter than	
	same as	02 Standard variety
3▲7	cm taller than	01

* Vegetative height. Height of vegetation excluding seedheads, measure at seedhead maturity.

38▲1	cm height	
	cm shorter than	
	same as	Standard variety
6▲1	cm taller than	01
2▲1		02

9. SEED, LEMMA, AND GLUME: Use seed harvested from PVP nursery, not commercial seed lots.

Glume

	mm length			mm width	
	mm shorter than		Standard	mm narrower than	Standard
	same as		Variety	same as	Variety
	mm longer than			mm wider than	

Lemma

	mm length			mm width	
	mm shorter than		Standard	mm narrower than	Standard
	same as		Variety	same as	Variety
	mm longer than			mm wider than	

	Glume/lemma length ratio

Lemma hairs (Use 1-9 scale where 1 = absent and 9 = many or very long)

	number keel hairs		length of keel hairs
	number margin hairs		length of margin hairs

60

* Seed (naked caryopses)

1▲29	mm length		0▲67	mm width	
	mm shorter than			mm narrower than	
	same as	02 Variety		same as	Variety
0▲10	mm longer than		0▲09 (0▲08)	mm wider than	01 (02)

* Explain if samples are blown Seedburo South Dakota Blower - 3 cm setting

0▲225	mg weight of 100 seed	
3390	Number of seeds per gram	
10 5 4	Number of seeds per gram less than	01 — 314 less than 02
	Seed weight same as	Standard Variety
	Number of seeds per gram more than	

10. LOW TEMPERATURE TOLERANCE (Winter hardiness)

6

1 = Low (Coastcross-1, common)
4 = Moderately Low (Coastal)
6 = Moderately High (Tifway, Guymon)
9 = High (Midiron)

11. DISEASES AND INSECTS (0=Not Tested, 1 = Susceptible, 2= Partial resistance/tolerant 3= Resistant):

0	Brown patch *Rhizoctonia solani*	0	Aphids
0	Dollar spot *Sclerotinia homoeocarpa*	0	Bermudagrass mite (*Eriophyes cynodoniensis*)
0	Fading out *Curvularia spp.*	0	Chinch bugs
0	Leafspot (*Bipolaris* spp.)	0	Ground pearl (scale)
0	Rusts (*Puccinia spp.*)	0	Grubs
0	Spring Dead Spot (Pathogen indefinite)	0	Thrips
0	Zonate leafspot (*D. gigantea*)	0	Whitefly
0	Other:_____	0	Other:_____

No diseases and insects were specifically tested. Aphids and and leafhoppers are frequently seen but not to the extent of visual damage. Leafspot periodically affects other bermudagrasses but none was observed on Wrangler in its development and testing.

12. INDICATE THE SEED PROPAGATED VARIETY THAT MOST CLOSELY RESEMBLES THE APPLICATION VARIETY FOR THE FOLLOWING CHARACTERS: For each of the following characters, indicate the degree of resemblance by placing in the column marked "D.R." one of the following numbers.

1= Application variety is less than comparison variety.
2= Same as.
3= More than, better, greater, darker, etc.

CHARACTER	VARIETY		D.R.	
Cold tolerance	01	02	++3	4
Rate of spread	01	02	1	2
Sod density	01	02	1	1
IVDMD				
Forage yield	01	02	3	2
Seed Yield		02		++3

13. Specify location and growing conditions below. Include location, age of plants, date of data collection (with daylength if possible), management conditions, etc.). fertilizer, herbicide, etc

Objective Description of 'Wrangler' Bermudagrass

I. Location of Test Area
- A. 1998 - Greenhouse - Enid, Oklahoma
  - a. Initially all the measurements were to be made in 1998 at two different locations but due several incidences of vandalism at a greenhouse located in Enid, OK the study was continued in 1999 to obtain 2 years or 2 locations of data. After the final easurements were made at the Enid location, the greenhouse was disassembled and moved.
- B. 1999 - Greenhouse - Lahoma, Oklahoma

II. Specific Growing Conditions
- A. Soil Mix
  1. 2 part peat moss
     1 part sand
     1 part vermiculite
     1 part perlite
     Lime, iron chelate + micronutrients
- B. 1 Gallon Black Plastic Pots
- C. Greenhouse Temperature
  1. Maintained at a minimum of 24 degrees Celsius
  2. Maximum of 38 degrees Celsius
- D. Greenhouse benches
  1. 1 meter from floor
- E. Pot Spacing
  1. Each pot was placed on 90 cm. centers
- F. Herbicides
  1. None, hand weeding when necessary
- G. Insecticides
  1. Diazinon
     a. Periodically for control of aphids
- H. Fungicides
  1. No fungicides were needed.
- I. Fertilizer
  1. Peter's Peat Lite Special 10-20-10
     a. Concentrate of 200-250 ppm injected in water supply 1 time weekly
     b. Plants watered to saturation
- J. Watering Schedule
  1. Once daily till saturation

III. Method
- A. Seeding
  1. Seed of Arizona Common, Guymon, and Wrangler were broadcast in 3 separate flats.
     a. 1998 - January 10, 1998
     b. 1999 - January 12, 1999
  2. Individual seedlings were transplanted into the 1 gallon plastic pots.
- B. Growth and Development
  1. Seedlings were watered as needed for development.
  2. Plants were fertilized 1 time per week with a hose attachment to inject fertilizer into the water supply to provide optimum growth.
  3. Diazinon insecticide was used once per month to prevent insect pressures.
- C. Clipping
  1. Plants were clipped to 1 inch April 1 and allowed to regrow for measurements.
- D. Measurement Equipment
  1. Meter stick for Plant Height measurements.

2. Starrett electronic caliper for Stolon and Shoots, Leaf Blade, Inflorescence, and Seed measurements.

E. Measurements Dates

Measurement	1998	1999
5. Stolons and Shoots	June 17-18	June 21-24
6. Leaf Blade	June 22-26	June 25-30
7 Inflorescence	June 30 - July 7	July 6-9
8. Plant Height	July 21-22	July 15-16

F. Specific Conditions

1. Inflorescence

a. Daytime temperatures in greenhouse range from 29 to 38 degrees Celsius

b. Humidity was greater than 75%

c. Daylength Schedule for Enid, Oklahoma is attached.

Item 14d. Exhibit D. Additional Description of the Variety

'Wrangler' bermudagrass is unique to other seeded bermudagrass varieties currently in commercial production . The combined characteristics of superior cold tolerance and improved seed production make it a potentially successful variety for use in large areas of the transition zone in the United States.

For over 15 years Johnston Seed Company has been producing 'Guymon' bermudagrass in the northwestern region of Oklahoma. 'Guymon' bermudagrass has been the only seeded variety bermudagrass commercially produced in Oklahoma. Typically most seeded varieties of bermudagrass eventually suffer severe winterkill when planted north of 35 degrees latitude. 'Guymon' has successfully been planted as far north as Kansas City, Missouri with very limited winterkill observed. Although 'Guymon' has been successful for turf and forage use, poor seed production in Oklahoma has hindered the widespread use the variety. Average seed yields of 'Guymon' in Oklahoma have historically been less than 150 lbs. pure seed per acre. Attempts were made for commercial seed production in Arizona but were not successful. 'Guymon's poor seed production has been attributed to marginal seedhead formation and poor seed set . 'Guymon' has received premium prices in the market place for many years because of its superior cold tolerance over other seeded varieties therefore allowing commercial production to remain economically feasible. The demand for a cold tolerant seeded forage bermudagrass has exceeded the supply 'Guymon' for several years. A higher seed producing variety was needed to meet this demand as well as make a seeded bermudagrass more affordable to those who wanted to plant it in states north of the traditional bermudagrass growing region. 'Wrangler' was developed to meet this growing demand.

In early seed production trials in Oklahoma the parents of 'Wrangler' showed significant improvements in seed production over 'Guymon'. Yields in excess of 250 lbs. of pure seed per acre were clearly obtainable. 'Wrangler' demonstrated prolific seedhead production early in the growing season compared to 'Guymon' which gradually begins flowering under optimal weather conditions. In the first year of commercial production 'Wrangler' produced 500 lbs. pure seed per acre registering a 400% increase in production over 'Guymon' in the same year with similar management practices. Sampling of seedset percentages resulted in greater than 90% for 'Wrangler' compared to less than 50% for 'Guymon'. Seedset of common bermudagrass in Arizona is typically does not exceed 60%. This attribute illustrates 'Wrangler's excellent fertility even in the ever changing weather conditions experienced in Oklahoma. No foliar diseases have been detected on 'Wrangler' or the six clonal parents since their development. There has been no smut or ergots observed on seedheads during evaluation or production. Early forage data in Oklahoma indicates dry matter production potential equal to that of Guymon but less than the elite vegetative varieties such as Hardie (Table 3 and 4). Winterhardieness is superior to Arizona common. Seeded plantings have been made as late as August 15 in Enid, Oklahoma (60 days prior to frost) with no visible winterkill the following spring. Morphologically, 'Wrangler' is significantly courser in texture than both Arizona common and Guymon. Stolons are larger in diameter with density being approximately 25% less than Guymon.

Table 3.

Table 1. Forage yields (tons dry matter/acre) of bermudagrass varieties in test 97-1, Panhandle Research Station, Goodwell, OK.

	1998 Harvests				
Variety	**6/10**	**7/20**	**8/19**	**10/12**	**Total**
Greenfield	1.69	4.14	2.34	0.74	8.92
Midland	1.69	3.64	2.37	0.94	8.64
Tifton 44	2.84	2.88	2.65	0.86	9.23
Hardie	3.92**	4.44*	2.94	1.70*	13.00**
Quickstand	2.36	3.93	2.63	0.95	9.86
74X 12-6	2.32	4.81**	3.04	1.67*	11.84*
74X 21-6	1.74	4.06	3.17	1.20	10.16
LCB 84X 16-66	2.82	4.50*	2.79	1.83**	11.93*
LCB 84X 19-16	3.85*	3.66	2.71	1.37	11.59*
ERS 94X 2-8	2.96	3.74	3.20	1.76*	11.65*
ERS 94X 5-12	1.44	3.84	3.23	0.73	9.23
ERS 94X 6-13	1.29	3.17	2.76	0.87	8.08
ERS 94X 13-9	1.79	4.35	2.57	0.78	9.49
A-12199	1.15	3.19	2.54	0.73	7.60
ERS-C	1.91	3.55	2.46	0.91	8.81
SCRS-C	2.74	4.04	2.79	1.05	10.62
Wrangler	2.64	4.02	2.70	0.65	10.00
CD 90160	2.76	4.52*	2.80	1.67*	11.75*
Guymon	1.85	4.18	2.82	0.81	9.65
Mean	2.30	3.93	2.76	1.12	10.11
CV(%)	27.09	26.99	22.87	26.47	16.29
LSD (5%)	0.88	1.50	NS	0.42	2.33

** Highest numerical value in column.

*Not significantly different from the highest numerical value in the column based on the 5% LSD.

NS No significant difference among varieties.

Table 4.

Forage Yields of Guymon and Wrangler Bermudagrasses. Test 96-4. Agronomy Research Station, Stillwater, OK.[1]

	1997			1998				2-Yr
Variety	**7/25**	**11/4**	**Total**	**6/16**	**8/11**	**11/24**	**Total**	**Mean**
	tons dry matter/acre							
Guymon	2.54	2.60	5.14	1.42	0.88	1.62	3.92	4.53
Wrangler	2.36	2.57	4.93	1.43	0.91	1.56	3.90	4.42
Mean	2.56	2.48	5.03	1.39	0.90	1.59	3.91	4.32
CV (%)	5	10	4	18	30	7	9	9
5% LSD	NS	NS	NS	NS	NS	NS	NS	NS

NS= Differences between the two varieties are not statistically significant.

DOCUMENTATION IN SUPPORT OF CERTIFICATE

An additional 145 pages contains Exhibit C data and the following three reports in support of this Certificate no. 200000065.

Item 16. Exhibit B-5. Forage Production of Bermudagrass Cultivars in Eastern Kansas, Joseph L. Moyer, Kenneth W. Kelley, and Charles M. Taliaferro. Southeast Agricultural Research Center, Kansas State University.

Item 16. Exhibit B-6. Productivity of Bermudagrass Cultivars in the Upper Cumberland Region, B. Bruce Greene, C Cooper King, and Donald M. Elkins, Tennessee Tech University.

Item 16. Exhibit B-7. Berrmudagrass for Livestock Forage Production in Kentucky, D.C. Ditsch, J. Henning, and J.W. Turner, University of Kentucky, 2002 Agronomy Research Report.

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U.S. DEPARTMENT OF AGRICULTURE
AGRICULTURAL MARKETING SERVICE
SCIENCE AND TECHNOLOGY DIVISION - PLANT VARIETY PROTECTION OFFICE

EXHIBIT E
STATEMENT OF THE BASIS OF OWNERSHIP

The following statements are made in accordance with the Privacy Act of 1974 (5 U.S.C. 552a) and the Paperwork Reduction Act (PRA) of 1995.

Application is required in order to determine if a plant variety protection certificate is to be issued (7 U.S.C. 2421). Information is held confidential until certificate is issued (7 U.S.C. 2426).

1. NAME OF APPLICANT(S)
Johnston Seed Company

2. TEMPORARY DESIGNATION OR EXPERIMENTAL NUMBER

3. VARIETY NAME
Wrangler

4. ADDRESS *(Street and No., or R.F.D. No., City, State, and ZIP Code, and Country)*
319 West Chestnut, P.O.Box 1392
Enid, Oklahoma 73701

5. TELEPHONE *(include area code)*
(580)233-5800

6. FAX *(include area code)*
(580)249-5324

7. PVPO NUMBER
20000065

8. Does the applicant own all rights to the variety? *Mark an "X" in appropriate block.* If no, please explain. [X] YES [ ] NO

9. Is the applicant (individual or company) a U.S. national or U.S. based company?
If no, give name of country _____ [X] YES [ ] NO

10. Is the applicant the original breeder? If no, please answer the following: [X] YES [ ] NO

a. If original rights to variety were owned by individual(s):
Is (are) the original breeder(s) a U.S. national(s)? If no, give name of country _____

b. If original rights to variety were owned by a company: [ ] YES [ ] NO
Is the original breeder(s) U.S. based company? If no, give name of country _____

11. Additional explantion on ownership *(If needed, use reverse for extra space):*

See attached agreement between Johnston Seed Company and Oklahoma Agricultural Experiment Station

PLEASE NOTE:

Plant variety protection can be afforded only to owners (not licensees) who meet one of the following criteria:

1. If the rights to the variety are owned by the original breeder, that person must be a U.S. national, national of a UPOV member country, or national of a country which affords similar protection to nationals of the U.S. for the same genus and species.

2. If the rights to the variety are owned by the company which employed the original breeder(s), the company must be U.S. based, owned by nationals of a UPOV member country, or owned by nationals of a country which affords similar protection to nationals of the U.S. for the same genus and species.

3. If the applicant is an owner who is not the original breeder, both the original breeder and the applicant must meet one of the above criteria.

The original breeder may be the individual or company who directed final breeding. See Section 41(a)(2) of the Plant Variety Protection Act for definition.

AGREEMENT BETWEEN
JOHNSTON SEED COMPANY
AND
OKLAHOMA AGRICULTURAL EXPERIMENT STATION
REGARDING
BERMUDAGRASS GERMPLASM

The Oklahoma Agricultural Experiment Station (hereafter called OAES) through its project H-1361, (Pasture, Range and Turfgrass Breeding) has conducted breeding research resulting in the development of new seed-propagated bermudagrass germplasms (breeding lines) that may be used to construct commercial seed-propagated varieties for forage or turf. Said research was carried out with significant financial support from the U.S. Golf Association and the Oklahoma Center for the Advancement of Science & Technology, both of whom urge and support collaboration with private industry in commercializing products/services emanating from sponsored research. The Johnston Seed Company, Inc. of Enid, Oklahoma (hereafter called JSC) collaborated with OAES in evaluating said bermudagrass germplasms for seed production and adaptation traits. Both OAES and JSC recognize the need for and interest in expediently developing and bringing to market cold-tolerant, seeded varieties of bermudagrass for forage and turf. JSC desires to provide facilities and technical expertise as necessary to construct such varieties using said germplasms. To achieve these goals JSC and OAES enter this cooperative agreement.

OAES grants JSC the exclusive right to propagate, name, and market seeded bermudagrass varieties derived by JSC from germplasms supplied by OAES under terms of this agreement and the original agreement signed.

a. JSC agrees to produce commercialized varieties as best possible in sufficient volume to meet the market demand.

b. JSC agrees to follow certification standards as used to ensure the quality of grass seed.

c. JSC agrees to vigorously advertise and promote the varieties in the region of adaptation most likely to be a market for the variety and said advertising shall conform to such laws, rules, and regulations relating to required labeling and truth in packaging as are in force when such advertising is promulgated.

d. JSC agrees to pay a royalty fee for as long as this agreement is in effect. A royalty fee of [redacted] shall be paid to OAES based on first sale price on all varieties sold the previous year and collected by JSC. First sale price is defined as the price per pound paid to contract growers of the varieties. The first sales price for the varieties produced on the JSC's land would be mutually agreed upon by OAES and JSC.

e. OAES agrees to use an amount not to exceed [redacted] the first year [redacted] the second year of the fee due to the OAES in payment of royalties by JSC for advertising and promotion of varieties developed from the germplasm licensed to JSC in this agreement. JSC agrees to match at least the minimum of the funding for advertisement by OAES. All advertising and promotion after the second year of the contract will be paid solely by JSC.

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f. Royalties will not be paid for any JSC production used for seed stock to establish seed production fields.

g. Application for protection of varieties under provisions of the Plant Variety Protection Act (PVPA; Pub. L. 103-349) shall be at the discretion of JSC. JSC shall pay for any direct costs of filing applications for plant variety protection (PVP) and will be considered owner of the PVP certificates issued in response to application. JSC will be responsible for seeking redress for infringement of PVP provisions for protected varieties developed under this agreement. OAES agrees to offer technical assistance, i.e. variety identification, testimony, etc. in pursuing litigation for infringement of provisions.

h. JSC shall have the authority to sublicense to growers. Sublicenses will be required to meet all provisions of this Agreement. The format and substance of any sublicense agreements will be determined by negotiation between OAES and JSC.

i. OAES Project leader will offer technical support in preparation of patent or PVP applications, product information and recommendations, review of advertisements and literature. Appropriate OAES and JSC personnel shall jointly author documents registering respective varieties with the Crop Science Society of America to be published in the journal *Crop Science*.

j. Termination: The term of the Cooperative agreement shall be ten years extending from the date of approval by the OSU Board of Regents. After ten years, this agreement may be extended annually by mutual agreement of both parties. This agreement and all options herein shall terminate when JSC terminates the sale of all these varieties developed from the germplasms provided by the OAES.

k. All payments due OAES shall be computed and paid on an annual basis with payment to be made on or before November 30th of each year and with payment to be accompanied by an accounting of sales made to date. Such accounting of the agreement shall include investments in advertising and promotion.

l. JSC agrees to make it's books and records pertaining to this subject available for inspection and audit by OAES.

APPROVAL:

D. C. Coulter for CBB 8/9/95

C. B. Browning, Dean & Director — Date
Oklahoma Agriculture Experiment Station
Division of Agricultural Sciences
and Natural Sciences
139 Agricultural Hall
Oklahoma State University
Stillwater, OK 74078

Leroy Mack 7-28-95

Leroy Mack, President — Date
Johnston Seed Company
411 West Chestnut St.
P.O. Box 1392
Enid, OK 73701